

AMPS LLC
Analyzing Medical Parameters for Solutions

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TITLE

Electra_320 User Manual

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1. Proposed and Intended Usage

This document is intended to illustrate the usage of **CER-S** software (Continuous ECG Recording – Suite; internal name is **Electra**).

CER-S is designed to offer a framework for the interaction of different software-modules providing advanced solutions for continuous ECG recording (CER).

It provides a way to display continuous ECG recordings and to perform automatic ECG beat detection with ECG template generation and Arrhythmia detection using AMPS ABILE algorithm, and to review and manually edit the computed information using several Graphical tools, designed to easily spot outlier.

The software also enables computation of the beats' measurements using AMPS BRAVO algorithm.

Last it provides a way to generate aECG HL7 XML (v. 2) files, which can be used for the submission of continuous ECG recordings to the FDA Warehouse.

In addition, the tool provides a command-line for batch analysis.

In the initial sections of this document the graphical interface will be presented while in the last section, command-line usage will be introduced.

2. Abbreviations and Conventions Used in the Manual

ECG	Electrocardiograph
CER	Continuous ECG Recording
Median	Representative Beat data
Rhythm	Standard ECG data
TPW	Timepoint Window
AW	Analysis Window
RA	Rhythm Annotation o Arrhythmia Annotation
NR	Noise Region
RBE	Rhythm & Beat Editor Display
ACEA	AMPS Binary Session file
ABILE	AMPS algorithm for ECG beats and Arrhythmias and detection
BRAVO	AMPS algorithm for the automatic measurement of ECG intervals and amplitudes

3. Procedures for System Use

3.1. Getting Started

CER-S software installation is trivial: the setup file (Setup_CER-S_320.exe) provided by AMPS personnel must be launched as Administrator.

Thus the setup file shall not be double-clicked, but instead the secondary mouse button shall be clicked on the file and the entry “ Run as administrator” shall be clicked.

Here, following defaults settings, CER-S software is installed together with all the required libraries and modules.

After the user has completed the installation of the software, the application can be launched by double-clicking the CER-S.exe program file. The program file is typically installed in the “C:\Program Files (x86)\AMPS\CER-S” folder.

The user can also launch the software via the CER-S desktop icon or from the Start Menu.

The software can also be launched by command-line. Refer to section 3.1 of the System Manual for all the details and the list of command-line flags. Section 3.2 contains examples of command-line.

When the software is loaded, it displays an empty graphical interface and up to eleven menus on the top left (depending on the licensed version), as displayed in Figure 1.

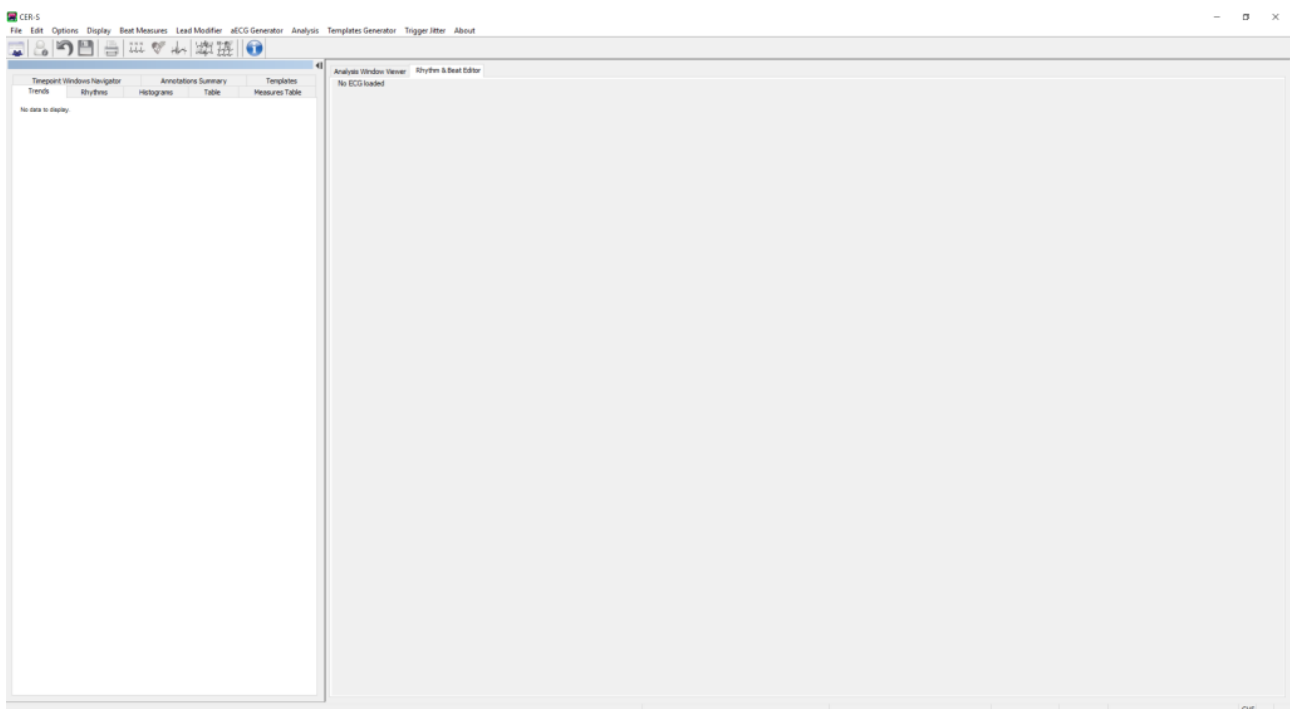


Figure 1 – CER-S display, initial empty screen

3.2. Supported Input formats

The software supports the display and analysis of continuous ECG recordings for the following ten formats:

- ISHNE
- MIT (WFDB)
- aECG FDA HL7 XML, version 2
- Getemed
- MyPatchSL
- STXML
- Binary DAT
- Binary WV
- CSV
- JSON

To load an ECG record, in the **File** menu select the *Open Record* menu entry. This will display a new dialog box (shown in Figure 2), where the user can select the ECG recording to load, filtering by file type.

When the user has selected the record, the first seconds ECG the data are displayed in the Continuous ECG Viewer or Rhythm & Beat Editor tabs according with the display settings as shown in Figure 10.

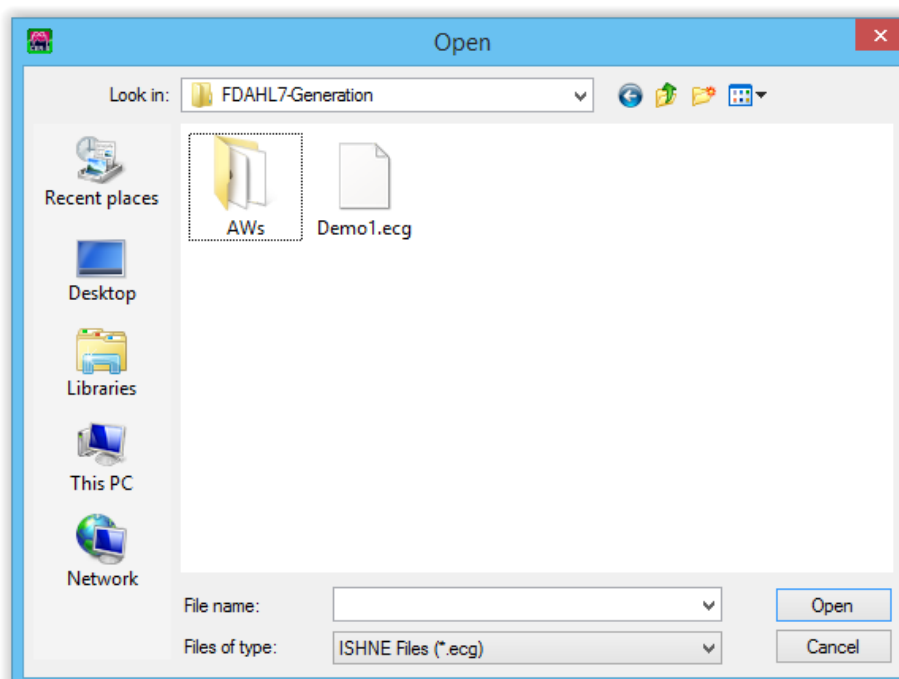



Figure 2 – CER-S continuous ECG record loading dialog

It is possible to load ECG records from an archive using the CER-S Recordings Manager. Refer to the next section for details.

3.3. Recordings Manager

To open the recordings manager, select *Recordings Manager* menu entry in the **File** menu or click the  toolbar button.

The *Recordings Manager* (Figure 3) is a dialog where is possible to select the ECG Record to be opened with CER-S. The records are arranged in user-created archives and are displayed in a table

For each record, the following information are displayed as columns, by default in the list:

- Progressive number of the record in the selected DB
- Subject ID
- Subject Name
- Data/Time of recording
- Record length
- Number of leads
- Sampling Rate (Hz)
- File Format (Type)
- Status (refer to section 3.3.2 for details)
- Analysis performed (refer to section 3.3.3 for details)

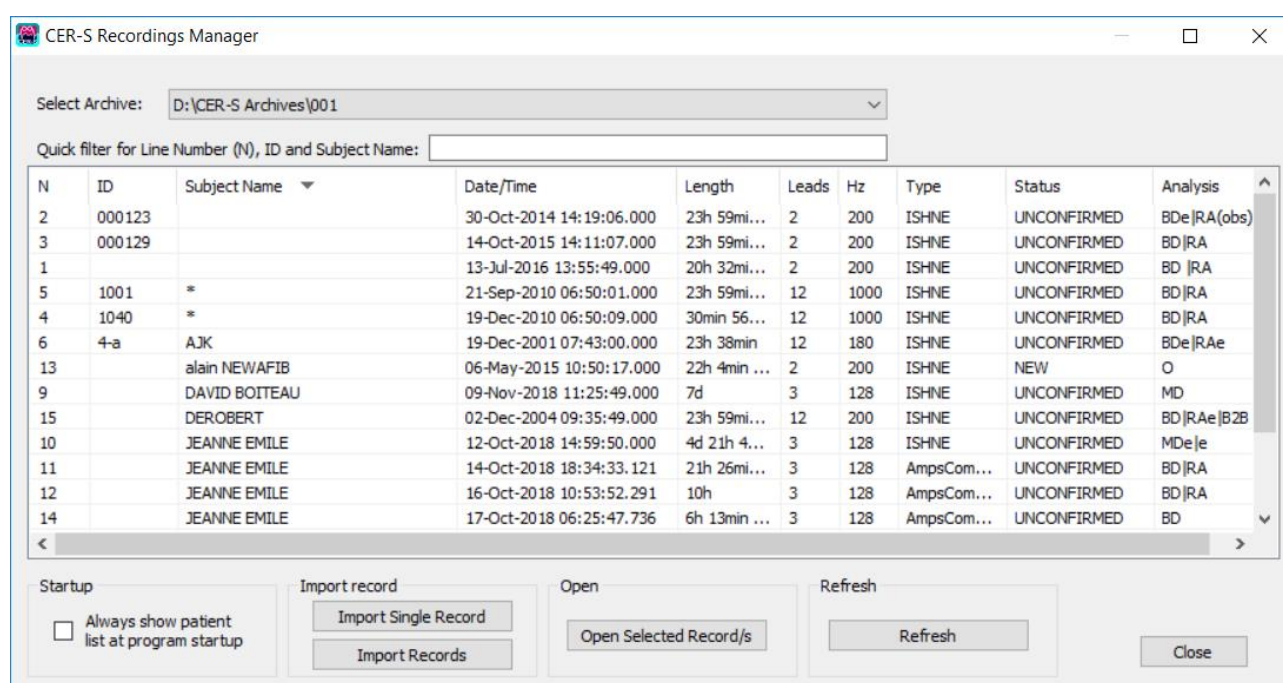


Figure 3 – CER-S Recordings Manager

The order of the list can be changed clicking on the header of the desired sorting parameter and the content of the list can be filtered, by typing some text on the text box below the Select archive menu. Filtering is simultaneously performed on:

- N - line number (first column)
- ID - Subject ID (second column)
- Subject Name (third column)

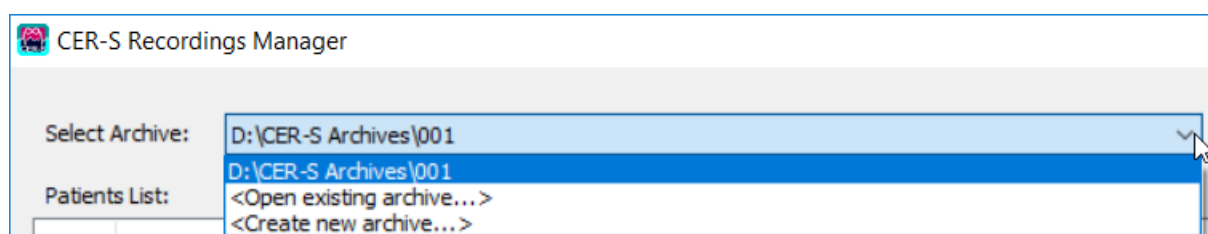
In order to open one or more record in CER-S there are various options:

- double click on a row of the list to load the corresponding record
- select one or multiple rows via SHIFT or CTRL keys and click the "Open Selected Record/s" entry to load the corresponding records

- select one or multiple rows via SHIFT or CTRL keys, click the secondary mouse button on the selection and select the "Open Record/s" entry to load the corresponding records
- In case more than one are selected, the first one (top most) will be loaded and then in CER-S the user will have the option to load the next/previous selected records, via "Go to next selected record" or "Go to previous selected record" entries from the File menu.

Go to previous selected record	F2
Go to next selectd record	F3

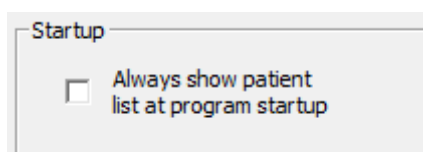
To populate the table, an archive must be selected from the dedicated menu:



From the menu is possible to:

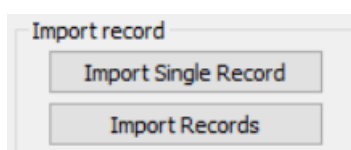
- Select an archive from the list
- Open an existing archive which is not present in the list (upon selecting the corresponding entry, the user is prompted to select the folder where the archive is located)
- Create a new archive (the user is prompted to select the archive location, which must be an empty folder).

It is possible to show the recordings manager at CER-S startup by flagging the correspondent checkbox.



3.3.1. Import record

When an archive is selected, it is possible to import a record by pressing the "Import Single Record" or "Import Records" buttons.



In case the former button is pressed, the user will have to select recording the file from the file system, then, when the file has been selected, on the dedicated dialog (Figure 4), it will

be possible to customize the actions to be performed after the record importation in CER-S Recordings Manager, namely in case the "Remove original record" is enabled, the original record file will be deleted and if "Run automatic analysis" is set to Yes, Beat Detection (ref. to sec. 3.20) and Rhythm Analysis (ref. to sec. 3.20.2) will be automatically launched using the current settings.

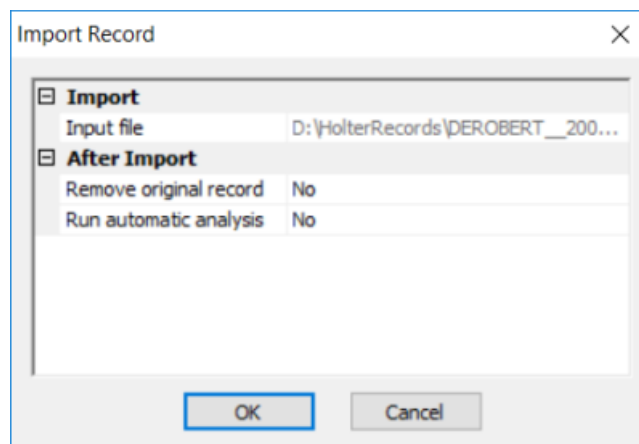


Figure 4 – Recordings Manager, importing a single record

Depending on the length of the record that is being imported, Multiday Analysis may be automatically launched instead of Beat Detection and Rhythm Analysis. Add the end of the importation process, demographic information are shown and can be manually edited by the user, by clicking Update button.

Clicking the "Import Records" button, a new dialog (Figure 7) is displayed where the user can edit the input folder (the last used one is remembered), choose whether records in subfolders shall also be imported and if duplicate recordings shall be imported. Duplicate recordings are records with identical date of recording, length, subject ID and subject name. In the 'Filter' field, the extension of the record files to import must be selected.

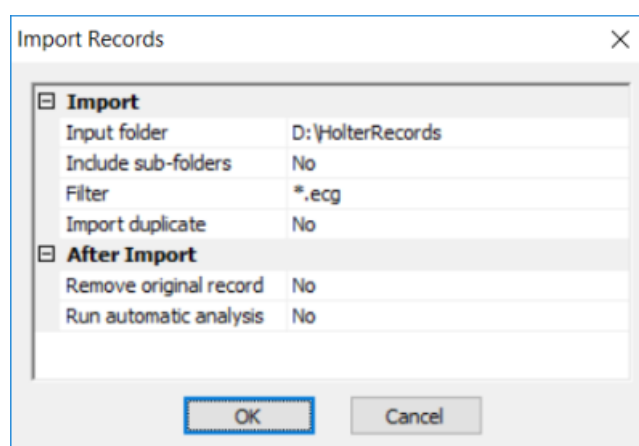


Figure 5 – Recordings Manager, importing multiple records

Similarly to the single import record, it is also be possible to customize the actions to be performed after the records importation in CER-S Recordings Manager, namely in case the "Remove original record" is enabled, the original record files will be deleted and if "Run automatic analysis" is set to Yes, Beat Detection (ref. to sec. 3.20) and Rhythm Analysis (ref. to sec. 3.20.2) will be automatically launched using the current settings.

Depending on the length of the records that are being imported, Multiday Analysis may be automatically launched instead of Beat Detection and Rhythm Analysis.

When the import process is completed, the recordings manager is automatically updated with the new imported record(s) as shown here below.

Patients List:

N	ID	Subject Name	Date/Time	Length	Leads	Hz	Type	Status	Analysis
15	PSECG		01-Jan-1900 00:00:00.000	02:14:21	2	250	Binary ...	UNCONFIRMED	BD/RA

Figure 6 – Recordings Manager - Example of an imported record on which beat detection and rhythm analysis have been performed

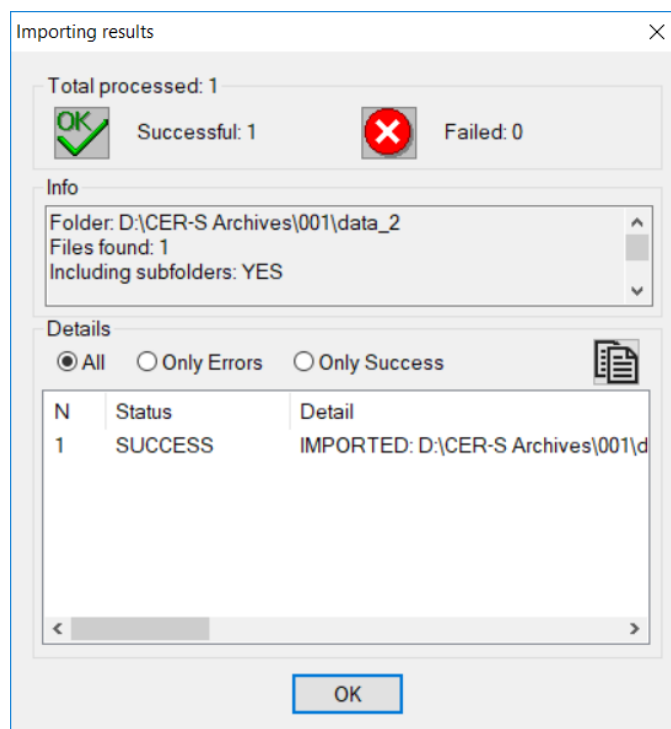


Figure 7 – Example of import results dialog

3.3.2. Record Status

Individual ECG record files could have one of the following three status:

- NEW (the record has not been edited and no analysis has been performed and it is editable)
- UNCONFIRMED (the record has been analyzed/edited and is not finalized)
- CONFIRMED (the record has been finalized, editing is no longer allowed)

To mark a record as CONFIRMED, select the *Confirm Record* entry in CER-S **File** menu.

To mark a record from CONFIRMED to UNCONFIRMED, select the *Unconfirm Record* entry in the **File** menu.

3.3.3. Analysis status

The analysis status gives information about the analysis/review performed on each ECG record and it is displayed in the CER-S status bar.

Recording: 19-Dec-2001 07:43:00.000 [23:38:00]	Selected Time: 19-Dec-2001 07:43:22.500	UNCONFIRMED	Oe RAe B2B
--	---	-------------	------------

Figure 8 – Example of status bar: the status is UNCONFIRMED, the original annotations have been edited, Rhythm Analysis and Beat Measures analysis have been performed

The possible analysis status are:

- O: original beat annotations loaded from the original record file)
- Oe: original beats annotations edited
- BD: beat detection has been performed, beat annotations are detected by ABILE algorithm, see section 3.20
- BDe: Beat Detection performed and beat annotations edited
- RA: Rhythm Analysis performed, see section 3.20.2
- RAe: Rhythm Analysis performed and rhythm annotations edited
- RA(obs): Rhythm Analysis performed, but some modification affected the analysis, it is obsolete and should be re-launched
- B2B: Beat Measures Analysis has been performed, see section 3.21
- B2Be: Beat Measures Analysis has been performed and families' measures edited, see section 3.21.3
- B2B(obs): Beat Measures Analysis performed, but some modification affected the analysis and some families should be re-analyzed
- T: templates generated by "Templates Generator", see section 3.22.
- MD: Multiday analysis has been performed
- MDe: Multiday analysis performed and some editing has been performed

The full status is divided in three groups, separated by the character "|".

First group is O, BD or MD with "e" and "T" possible suffixes.

Second group can be missing or RA, with "e" and "(obs)" possible suffixes.

Third group can be missing or B2B, with "e" and "(obs)" possible suffixes.

3.3.4. Adding removing record details

It is possible to customize the columns available in the recording manager by clicking the secondary mouse button on any column's header and then specifying for each entry if it must be visible or hidden; the order of the columns can also be modified, by selecting a entry and then clicking on "UP", "DW" buttons.

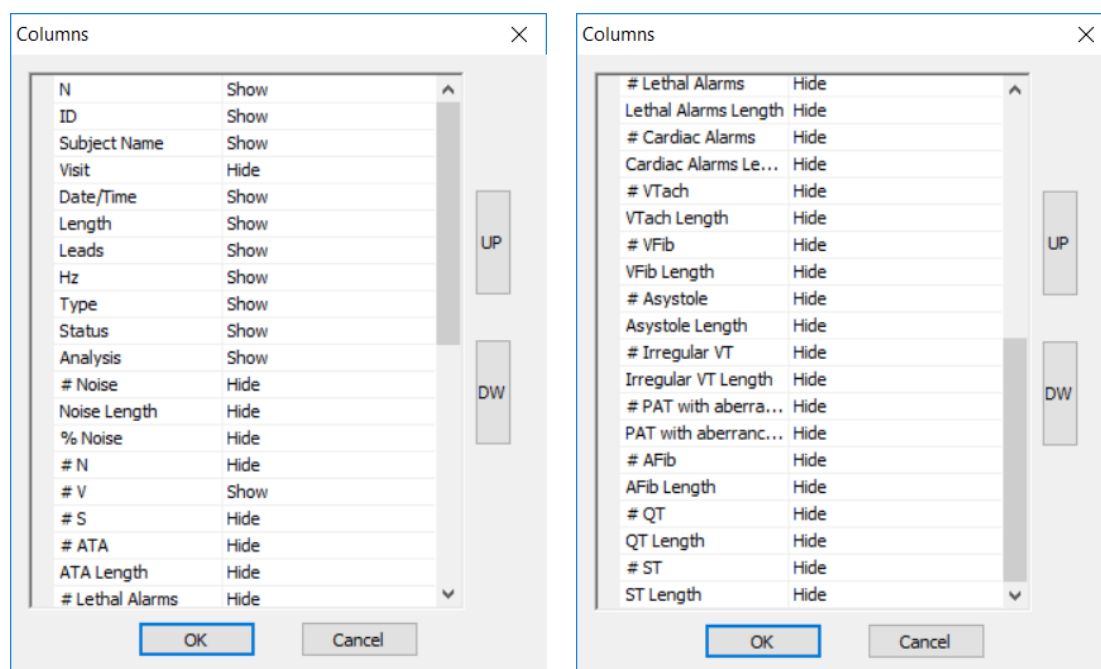


Figure 9 – Editing of displayed column-details in the Recording Manager

3.4. Continuous ECG Viewer

Depending on the licensed CER-S configuration this module may not be available.

Continuous ECG Viewer allows to display ECG waveforms and, in case they are present, visualize ECG annotations. There are two kinds of ECG annotations that can be visualized:

- ECG beat annotations
- Window area annotations

The Window area annotations can either be Timepoint Windows or Analysis Windows related to the aECG Continuous ECG generation, Noise Regions and Rhythm Annotations Windows related to Rhythm Annotation editing.



Figure 10 – CER-S display, with continuous ECG recording displayed in the Continuous ECG Viewer, with 12 x 1 layout

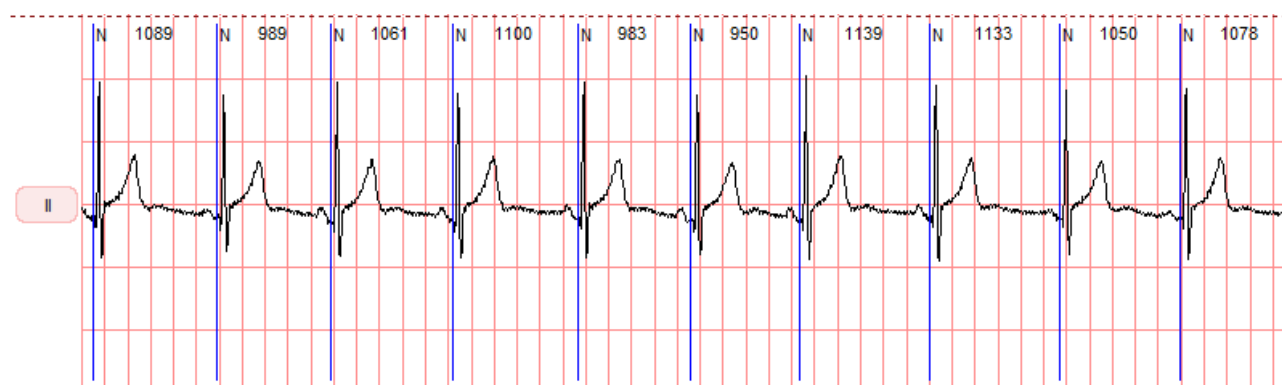


Figure 11 – ECG beat annotations highlighted in Continuous ECG Viewer, with vertical marker

3.4.1. ECG beat annotations

If the loaded Continuous ECG recording include ECG beat annotations, the annotations will be displayed in the annotation file. It is important to note that ECG beat annotations will only be loaded if the annotation file has the same filename as the Continuous ECG recording file and both the files reside in the same folder.

For ISHNE format, CER-S supports ECG beat annotations in both textual (.txt file extension) and binary (.ann extension) format.

ECG beat annotations for HL7 FDA XML v. 2 are typically stored in an external file but can occasionally be encoded within the XML itself.

Refer to Figure 10 and Figure 11 for examples of ECG beat annotations display.

In case Beat Detection/Editing has been performed and the current session has been saved (see section 3.24 for details), beat information will be automatically loaded from the "ACEA" session binary file stored in the same folder as the Holter record.

Beat information from the session file will override those from the standard annotation file.

3.4.2. Window area annotations

If Timepoint Windows or Analysis Windows have been loaded in CER-S, the *Continuous ECG Viewer* displays the sections of the record belonging to the related window shaded/highlighted in two different levels of green color. See Figure 12 for an example.

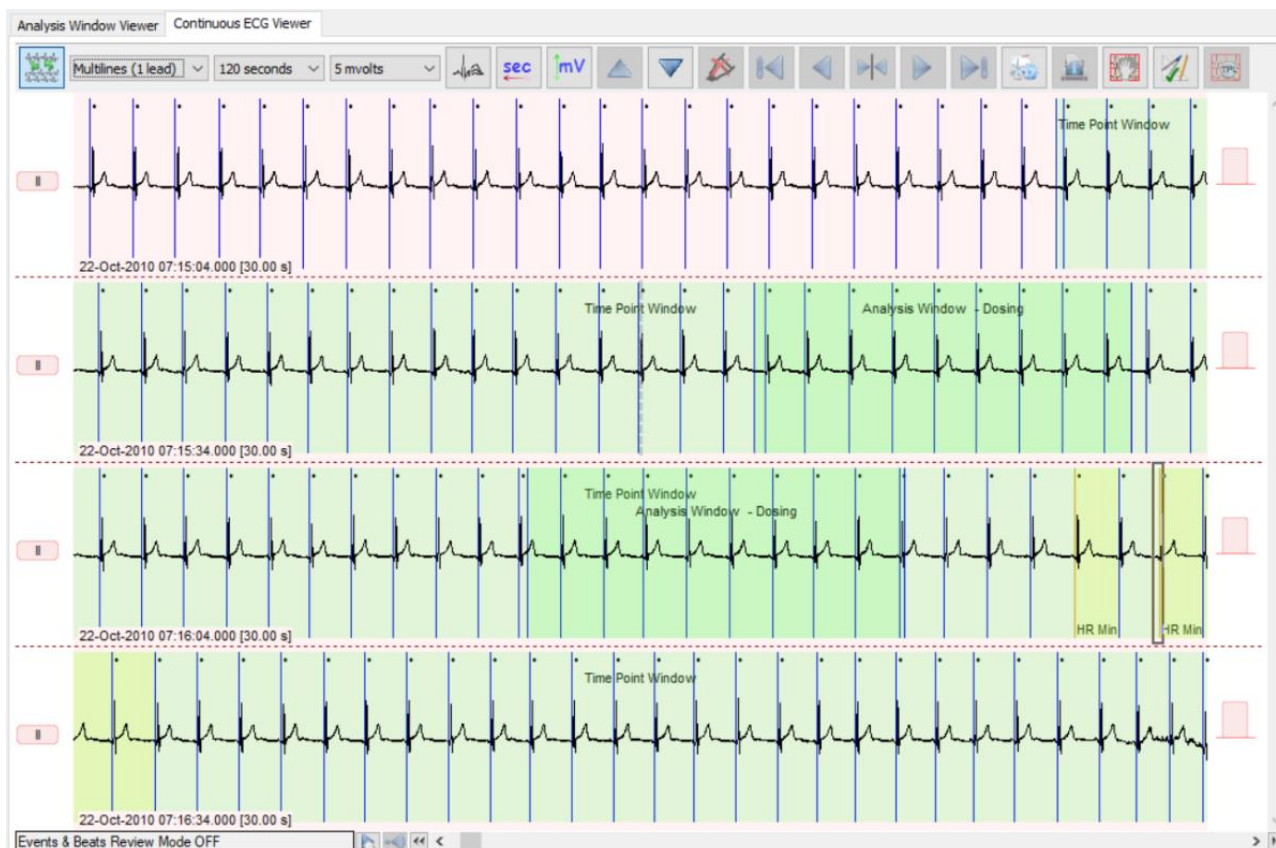


Figure 12 – Continuous ECG Viewer showing a Timepoint window and two Analysis Windows

Similarly, Rhythm annotations detected by the algorithm, manually entered via Rhythm & Beat editor or loaded from an "ACEA" file are displayed in red (Figure 13).

All colors can be changed in the Display Options dialog box, refer to section 3.29.1 for details.



Figure 13 – Continuous ECG Viewer, displaying a Rhythm annotation

When moving the mouse over an ECG beat, a gray rectangle is drawn, and the following tooltip is displayed if available (see Figure 14):

- Beat type
- Template ID it belongs to, with the overall number of beats of the Template
- Date/time
- RR and HR

Similarly, when moving the mouse over a Rhythm Annotation, the tooltip shown in Figure 15 is visualized.

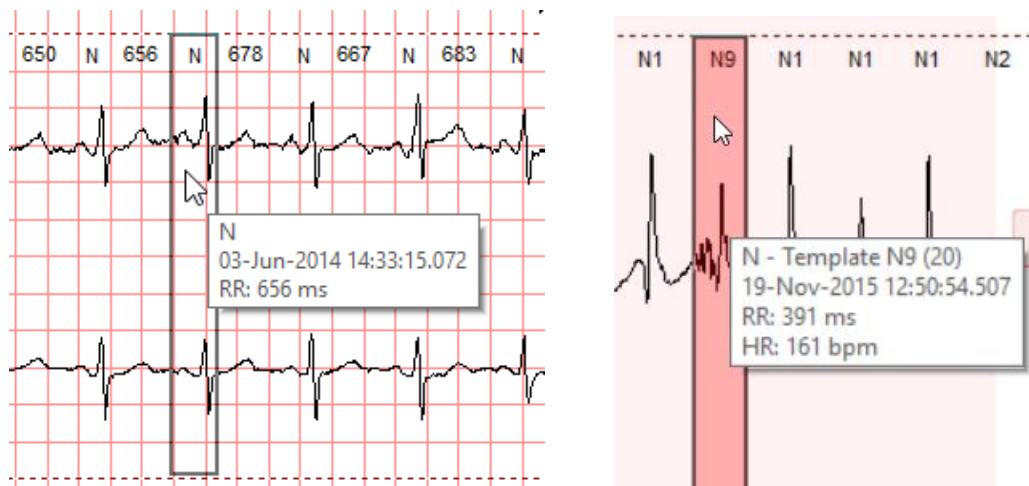


Figure 14 – Example of tooltips on an ECG Beat displayed in the Continuous ECG Viewer. The first one is related to ECG beat annotations loaded from an external file. The second one was detected by the Beat Detector, thus reporting the Template ID and HR

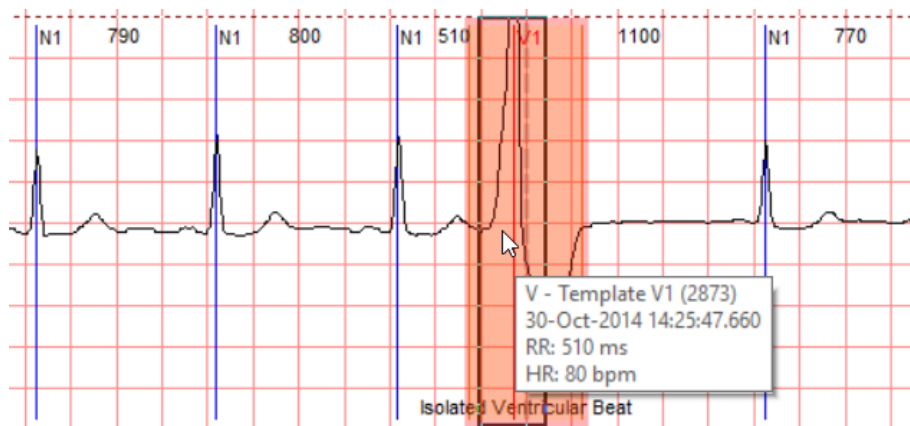
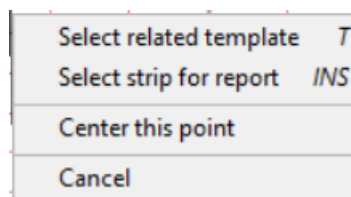


Figure 15 – Example of tooltip on Rhythm Annotation displaying the annotation type, time occurrence and related RR and HR

3.4.3. ECG Beat Interaction

Clicking the primary mouse-button on a single beat, the context menu is displayed where it is possible to:



- select the related template.
- select the ECG strip for report
 - in this case an ECG strip of 7s length centered on the selected beat will be flagged to be included in the report. The user can then edit the default strip label, the beat label, select the desired layout between 12 Leads and 3 Leads (II, V2 and V5) and increase the strip length.

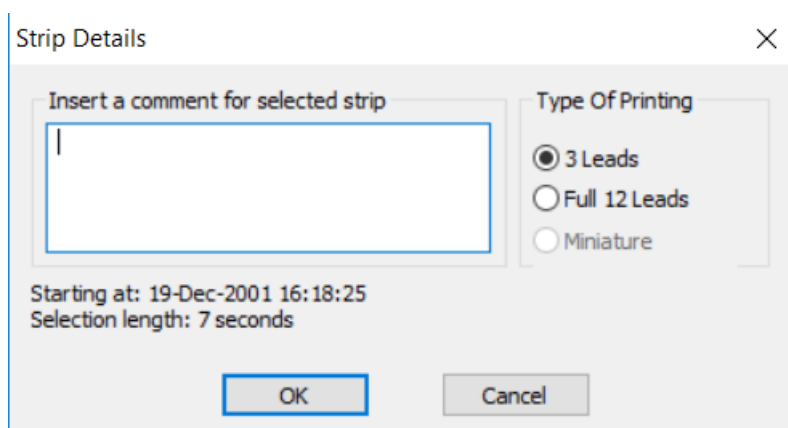


Figure 16 – "Strip Details" dialog allowing to edit a Strip label and select the strip layout

- "Center this point": make the selected point as the central point of the current view. In case of multiline, the selected point will be the center of the 2nd row (in case of 4 lines) or the center of the 5th row (in case of 10 lines).

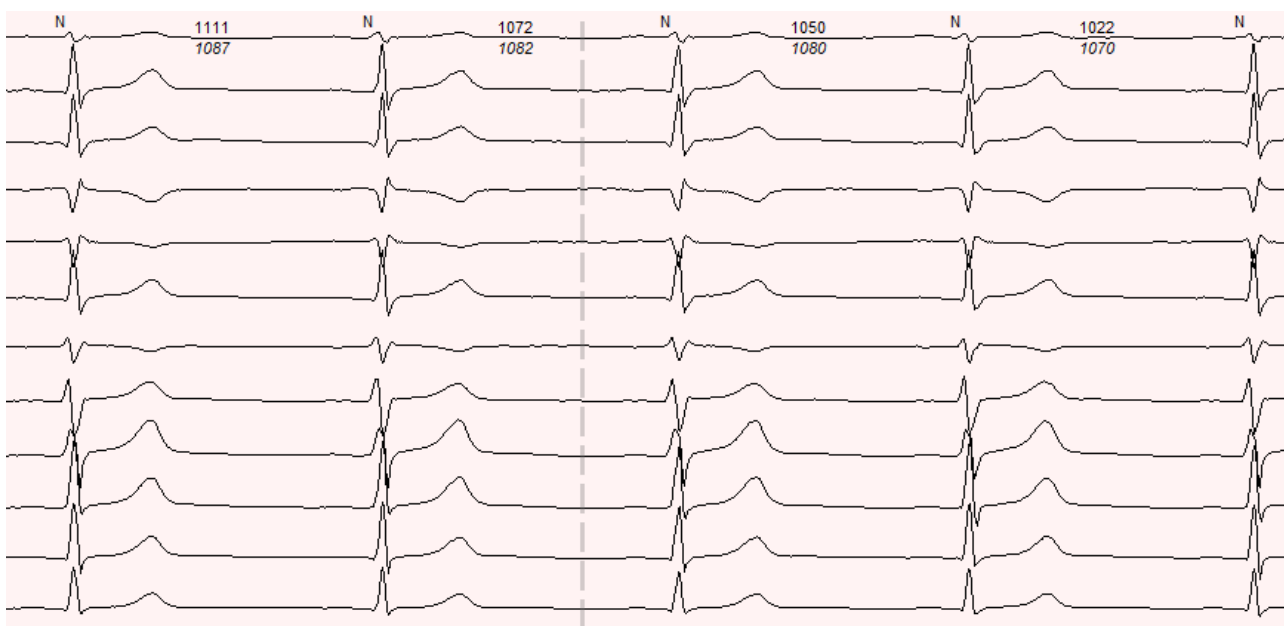
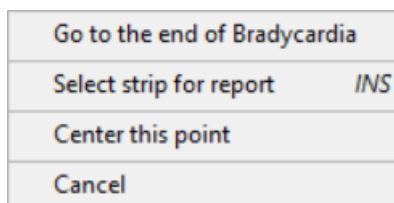


Figure 17 – the "Central point" of the strip is marked with a vertical grey dashed line

3.4.4. Annotation Interaction

Clicking the primary mouse-button on a window area annotation, the context menu is displayed where it is possible to:



- Display the beginning or end of the selected event in case it is not fully visualized
- select the ECG strip for report
 - in this case an ECG strip of 7s length (or multiple of 7s, in case an annotation longer than 7s is selected) centered on the selected annotation will be flagged to be included in the report. In case of an annotation longer than 42s, the strip will be truncated to a length of 42s. The user can then edit the default strip label, the annotation type, edit the desired layout between 12, 3 Leads (II, V2 and V5) and miniature (only in case an annotation longer than 7s is selected) and edit the strip length.

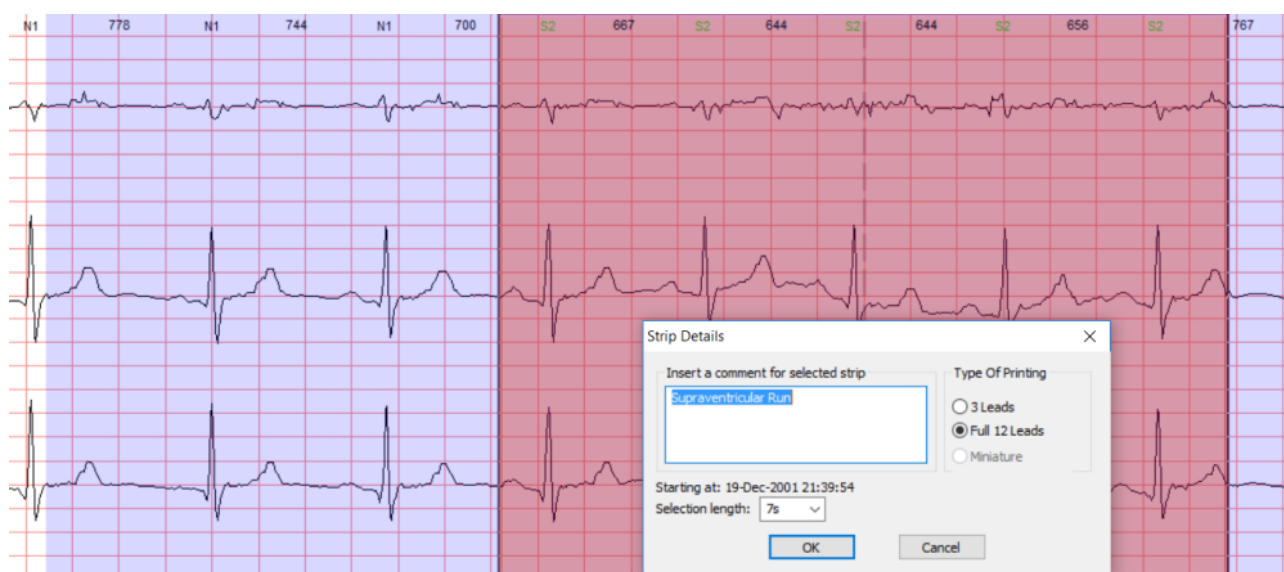


Figure 18 – "Strip Details" dialog for window area annotation

- "Center this point": make the selected point as the central point of the current view. In case of multiline, the selected point will be the center of the 2nd row (in case of 4 lines) or the center of the 5th row (in case of 10 lines).

3.4.5. Display Configuration

In the *Continuous ECG Viewer*, the user can customize the visualization of the ECG by adjusting the various parameters via the toolbar buttons or drop-down menu entries.



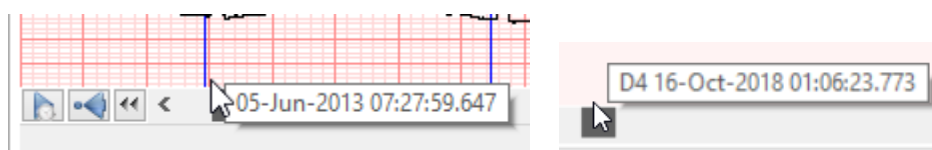
To modify the grid display and layout and to change the color of the ECG waveforms and the various annotations, refer to the Display Options on section 3.29.1.


Information regarding the continuous ECG time and current position, with millisecond precision, are displayed in the status bar at the bottom of the *Continuous ECG Viewer*. In the following example, the continuous ECG starts at 7:43:00 and has a length of 23 hours and 38 minutes. The selected time (i.e. the central time displayed in Figure 17) of the displayed ECG signal is 14:21:07.





Recording: 19-Dec-2001 07:43:00.000 [23h 38min] Selected Time: 19-Dec-2001 14:21:07.406

The end of the recording is available on the tooltip when the mouse cursor is on the first field.

The ECG waveforms can be scrolled using the horizontal scroll-bar at the bottom of the Viewer. While scrolling, a tool-tip indicates the current position within the ECG with a millisecond precision. In case of a record longer than 24 hours, the tooltip will also indicate the day of recording.



By clicking on the button  next to the horizontal scroll-bar, it is also possible to slightly scroll the current page backwards to the whole second (i.e. .000 ms).

The scrolling buttons  and  allow to scroll the ECG signal backward and forward respectively, by one tenth of the displayed time amount. Scrolling buttons  and  allow to scroll the ECG signal backward and forward respectively by the width of the displayed window.

3.4.5.1. Multiline Display



Standard / Multilines ECG waveform display can be toggled using the second toolbar button from the left. The former allows for a more detailed ECG waveform display, with the latter display it is possible to display long portion of signal, up to 30 minutes, on a maximum of 3 leads.

By clicking the secondary mouse button on the lead label, it is possible to change the leads to be displayed both on Standard / Multilines display.

“Standard” and “Multilines” displays are independent and can be differently customized. It is thus possible have different display layouts and different lead orders.

Examples of "Multilines" display are shown in Figure 12 and Figure 13.

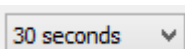
3.4.5.2. Lead display customization



The number of leads to display in the Viewer can be configured by selecting the appropriate entry from the leftmost drop-down menu. Selecting the entry "Multilines", it is possible to display the ECG signal in multiple lines. The maximum number of leads in multiple lines is three.

In case "Multilines" leads to be displayed are modified, this will not affect the "standard" display.

3.4.5.3. Time Display Customization

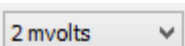


The number of seconds to display in the Viewer can be configured by selecting the desired interval from the second drop-down menu from the left.

In case of "Standard" display, available time durations are: 5, 10, 20, 30, 60 and 120 seconds. If the selected length is greater or equal than 60 seconds, a dot is displayed instead of the beat's label.

In case of "Multilines" display, available time durations are: 40, 60, 120, 180, 240, 300, 360, 600, 1200 and 1800 seconds. If the selected length is greater or equal than 60 seconds, a dot is displayed instead of the beat's label.

3.4.5.4. Voltage Display Customization



The amplitude resolution to display in the Viewer can be configured by selecting the desired resolution from the third drop-down menu from the left.

Available voltage resolutions are between 1 and 8 mV.

3.4.5.5. Superimposition Display



Standard/superimposed ECG waveform display can be toggled using the first toolbar button from the left.

Shown below is an example of Superimposed ECG waveforms.

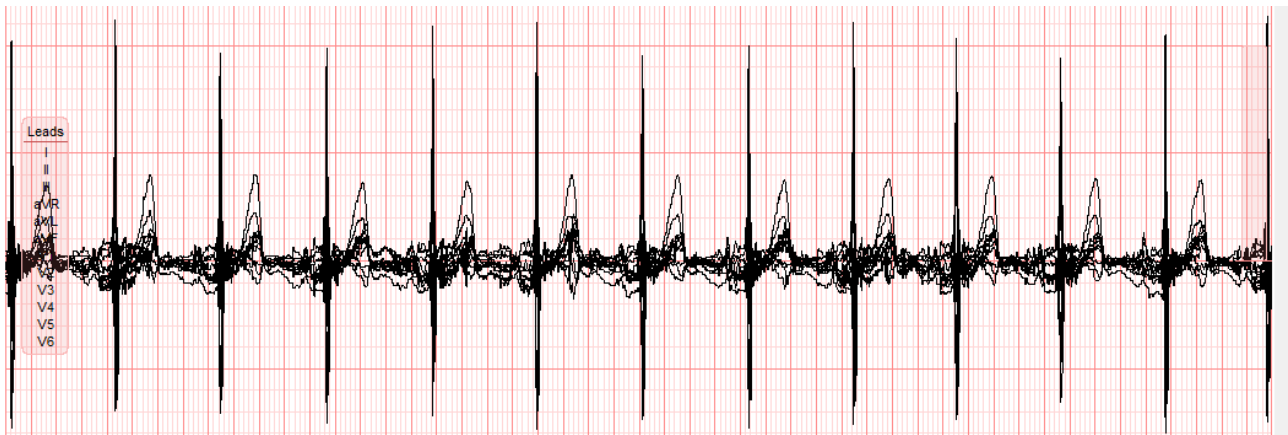


Figure 19 – Example of ECG waveforms drawn in Superimposed mode in Continuous ECG Viewer

3.4.6. ECG Calipers



Time (i.e. duration) and Voltage (i.e. amplitude) can be manually measured with the two available manual calipers.

Calipers can be moved around the screen and their length adjusted for correct measurements.

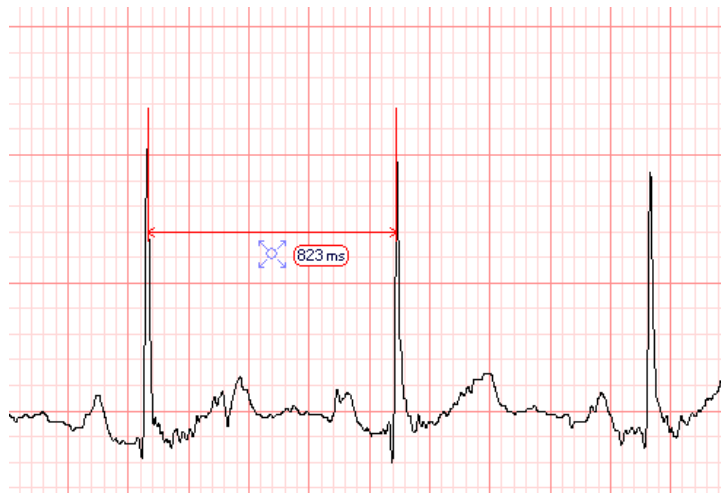


Figure 20 – Example of horizontal time-caliper to manually measure the time intervals

3.4.7. Change displayed leads



The current selection (single/multiple beats, noise regions or rhythm annotations) in the *Continuous ECG Viewer* can be reset using the fifth toolbar button from the left.

3.4.8. Reset Current Selection



The current selection (single/multiple beats, noise regions or rhythm annotations) in the *Continuous ECG Viewer* can be reset using the fifth toolbar button from the left.

3.4.9. Navigation

When multiple ECG beats, Noise Regions or Rhythm annotations are selected via one of the available “navigation” modules (Annotations Summary, Histograms, Tables, Templates or Trends) in the *Continuous ECG Viewer*, it is possible to navigate within the selection. Namely it is possible to display the previous/next of first/last item via dedicated toolbar buttons. The button at the center displays the current item in case of manually scrolling of the display.



Information regarding the display of the selected beats is displayed in the status bar at the bottom of the *Continuous ECG Viewer* as shown below, indicating that the 7th ECG beat is displayed, selected from the Time Trend display.

Trends selection sorted by Time (from Time vs RR) (7 of 19)

3.4.10. Edit Settings



Clicking on the “Edit Settings” button, the “Continuous ECG Viewer Settings” dialog is opened.

In the “RR visualization” panel, the user can decide whether to visualize the RR interval on the ECG signal.

RR display is automatically disabled if this would overlap with the beat label.

Rhythm & Beat Editor Settings

RR visualization

☒ Display RR

Current Item

☒ Always center the current item

☐ Do not center the current item

Review Modes

☐ Enable Rhythm Annotations & Beats Review Mode

☐ Mimic Template Layout

Context View

☒ Enable/Disable Context View

120 # of seconds [5-1800]

5 # of mvolts [1-10]

Leads to visualize:

Lead	Sel.
I	<input type="checkbox"/>
II	<input checked="" type="checkbox"/>
III	<input type="checkbox"/>
aVR	<input type="checkbox"/>
aVL	<input type="checkbox"/>
aVF	<input type="checkbox"/>
V1	<input type="checkbox"/>
V2	<input type="checkbox"/>
V3	<input type="checkbox"/>


OK Cancel

In the “Current Item” panel, the user can choose if the current item (ECG beat, Rhythm annotations or Noise Region) shall always be centered in the *Continuous ECG Viewer* or not. In the latter case, if more than one item is available in the displayed portion of ECG signal, the signal will not be shifted.


In the “Review Modes” panel, the user can choose to activate two modalities of review

- Rhythm annotations & Beat Review
- Template Review, by mimicking template layout

The former allows the simplification of events display of Continuous ECG Viewer in case of selection of ECG Beats, Rhythm annotation events and HR events, as described in section

3.4.13 and it can be activated with the toolbar button .

The latter is designed for the review of ECG beats within templates with a zoomed and optimized display layout, namely the Continuous ECG Viewer will be forced to display the leads available in the templates (in the same order) in single-line fashion, with a layout of 2 seconds and 2 mV resolution.

The user can then modify the layout, and these settings will be saved for future CER-S sessions; refer to section 3.4.14 and it can be activated with the toolbar button .

In the “Context View” panel, it is possible to enable/disable the context view and configure several parameters, namely:

- the number of seconds displayed in the context view.
- the resolution in mV of the ECG displayed in the context view.
- the leads to visualize in the context view.

The context view is available only in “Single Line mode”. In “Multiline”, it is automatically disabled.

The context view shows a portion of the Holter which contains the displayed ECG, highlighted with a gray rectangle (see Figure 21).

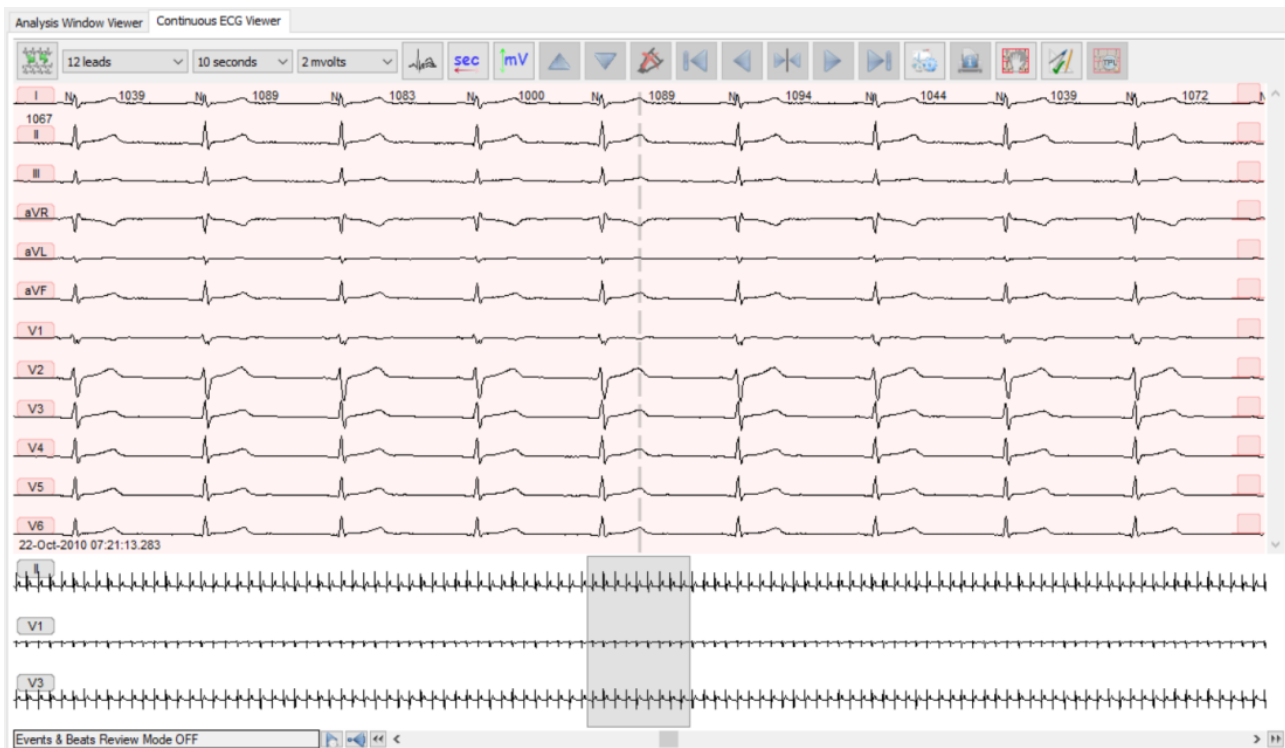


Figure 21 – Example of a 3 lead 120 seconds long context view, the ECG displayed above is highlighted with a grey rectangle

The interactive context view allows for changing the displayed ECG's position by dragging the gray rectangle.

3.4.11. Review of ECG Strips for Printing



Clicking on the "View Selected Strips" button from the *Continuous ECG Viewer* toolbar allows ECG Strips (both automatically and manually selected) to be reviewed and enables the user to:

- review the Strip
- modify the Strip layout, between 3 and 12 leads (if a continuous ECG recording with more than 3 leads is displayed) or miniature
- delete one or more strips
- change the Strip label

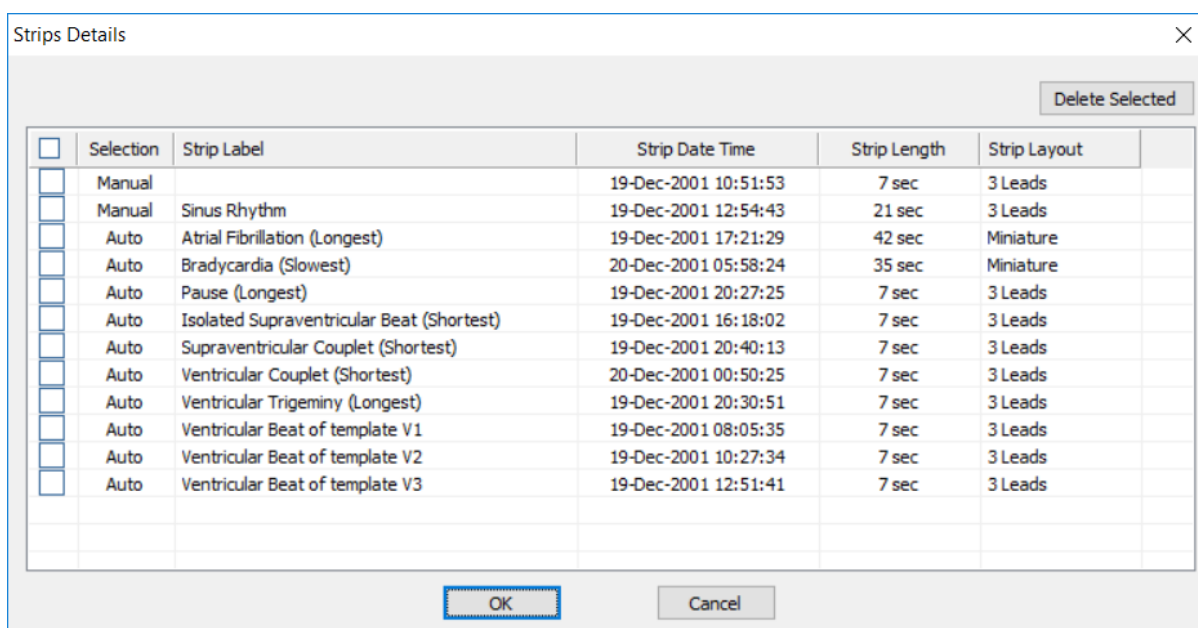


Figure 22 – "Strips Details" dialog, allowing to edit Strip label (preset to the Rhythm Annotation type) and select the strip layout for all pre-selected Strips

3.4.11.1. Review of ECG Strips for Printing in case of Multiday analysis

In case of Multiday analysis, the "View Selected Strips" button from the *Continuous ECG Viewer* toolbar only allows to review manually selected ECG Strips, as automatic ECG strips are reidentified at the end of the process on the current events, precisely at the time of printing the report.

3.4.12. Hide Rhythm annotation



Clicking this button allows simplification of the display of Continuous ECG Viewer, by hiding the visualization of RR intervals, beat detection positions and rhythm annotations not manually insertable, namely:

- Bradycardia
- Pause
- Prolonged RR Interval
- Supraventricular Tachycardia
- Isolated Supraventricular Beat
- Supraventricular Couplet
- Supraventricular Run
- Supraventricular Bigeminy
- Supraventricular Trigeminy
- Ventricular Tachycardia
- Isolated Ventricular Beat
- Ventricular Couplet
- Ventricular Run
- Ventricular Bigeminy
- Ventricular Trigeminy

3.4.13. Events & Beats Review mode



Clicking this button allows to activate the Rhythm annotations & Beat Review mode that simplifies the events display of Continuous ECG Viewer in case of selection of ECG Beats, Rhythm annotation events and HR events.

Here the list of Continuous ECG Viewer display modification in the various selections:

- ECG Beats
 - Only beats and noise regions are displayed, while rhythm annotation and HR events are hidden
- Rhythm annotations
 - Only beats, noise regions and selected rhythm annotation type are displayed, while the other rhythm annotation types and HR events are hidden
 - ECG beats cannot be selected, gray rectangles are hidden
- HR events
 - Only beats, noise regions and HR events are displayed, while all rhythm annotation are hidden
 - ECG beats cannot be selected, gray rectangles are hidden

Events & Beats Review mode can also be activated in the Continuous ECG Viewer settings (section 3.4.10), by enabling the related check-box.

☐ Enable Rhythm Annotations & Beats Review Mode

As Rhythm annotations & Beat Review mode deeply simplifies the events display, visualizing only certain ECG annotations or ECG Beats, the cardiologist may be induced to erroneously fail to assess all the events.

If Rhythm annotations Review mode is active, selection and editing of ECG beats is disabled.

3.4.14. Mimic Template Layout



Clicking this button allows to activate mimic template display in the Continuous ECG Viewer and it is designed for the review of ECG beats within templates in a zoomed and optimized display.

Continuous ECG Viewer will be forced to display the leads available in the templates (in the same order) in single-line fashion, with a layout of 2 seconds and 2 mV resolution. The user can then modify the layout, and these settings will be saved for future CER-S

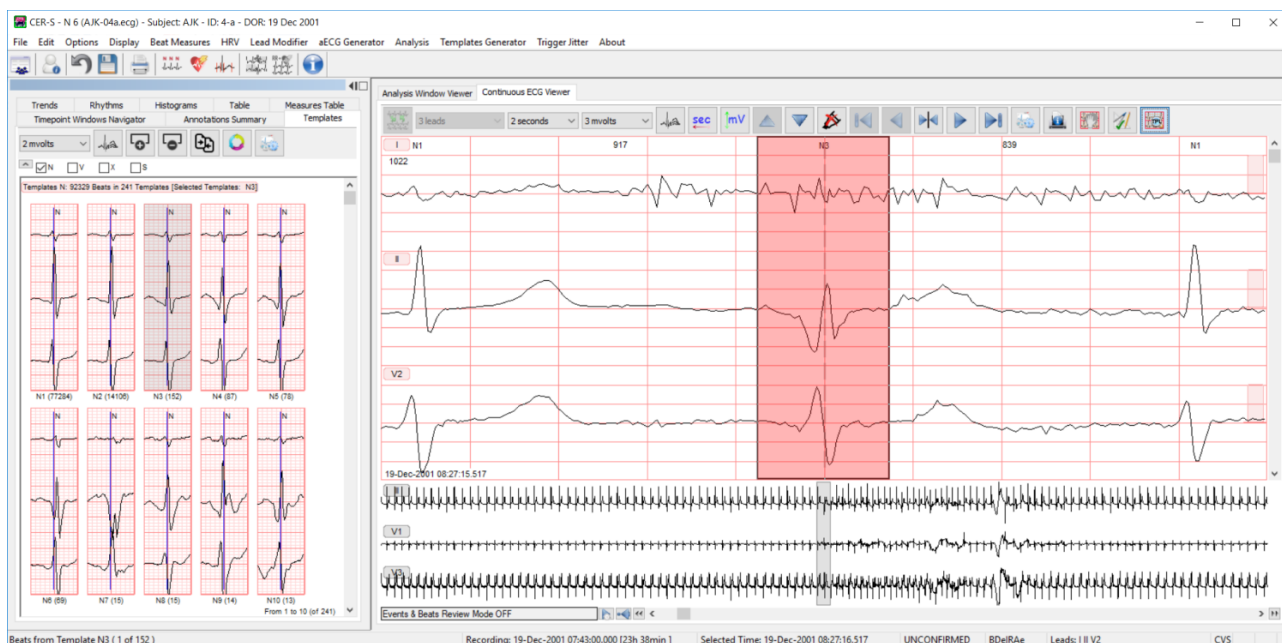



Figure 23 – "Mimic Template Layout" feature for optimized review of ECG beats within templates

3.5. Edit Menu - Undo Option

Selecting "Undo" entry from "Edit" Menu on the top left or clicking the  toolbar button, it is possible to erase the last performed change, thus reverting to the previous state. Note that an erased change cannot be automatically "re-done".

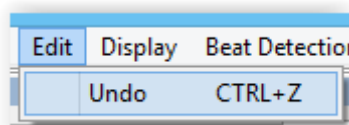
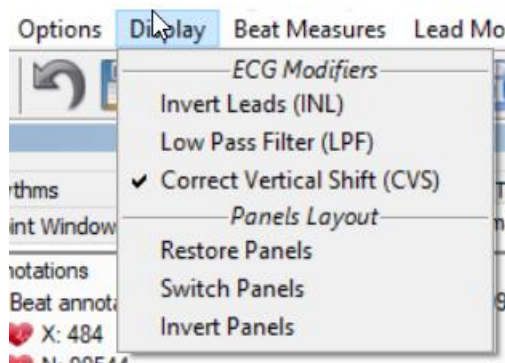


Figure 24 – "Edit" Menu

3.6. Display Menu - General Display Configuration

Display configurations are available from the **Display** Menu.

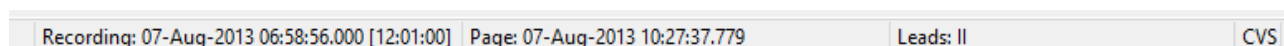


3.6.1.1. Correct Vertical Shift (CVS)

Continuous ECG recordings often present large baseline wandering, sometimes getting so large that the offset may cause certain leads not to be displayed in standard layout. For this reason, a wandering-removal option have been added (being active by default) that would vertically re-align the leads, removing the vertical shift.

Vertical shift can be enabled by selecting the *Correct Vertical Shift* entry from the **Display** Menu.

If the Correct Vertical Shift option is enabled, this is reported on the right side of the status bar of the Continuous ECG Viewer or Rhythm & Beat Editor Viewer with the CVS code.



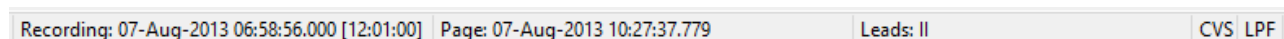
3.6.1.2. Low Pass Filter (LPF)

Continuous ECG recordings often present high frequency noise due to muscle activity and electrical interference.

For this reason, we have added a filtering option that removes the noise component by low-pass filtering the ECG signals with a cut-off of 60 Hz.

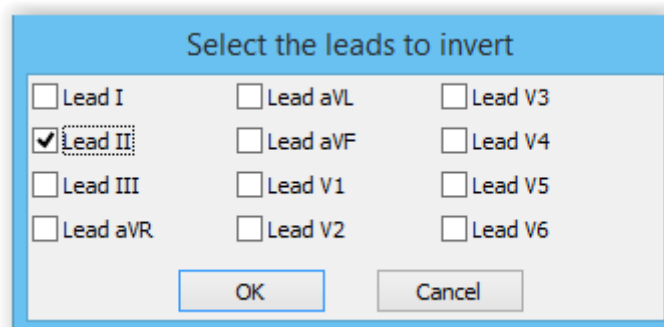
Low Pass filtering can be enabled by selecting "Apply Low Pass Filter" entry after clicking the Display Menu on the top left.

If the "Apply Low Pass Filter" is enabled, this is reported on the right side of the status bar of the Continuous ECG Viewer, with the LPF code.



3.6.1.3. Invert Leads (LPF)



It may occur that one or more leads are acquired with inverted polarity. To overcome this effect, we have added an option that allows the users to invert one or more leads. This option can be enabled by selecting the "Invert Leads" entry from the Display Menu on the top left, by selecting which the leads shall be inverted.





If the "Invert Leads" is enabled, this is reported on the status bar of the Continuous ECG Viewer by the code INL.

3.6.1.4. Panels Layout

The graphical display is always divided in two panels: LEFT and RIGHT displays. It is possible to change the size of each display using the mouse in a click-and-drag fashion over the vertical separator.

To minimize/restore the LEFT display, the user can click on the  /  icons.

To maximize/restore the RIGHT display, the user can click on the  /  icons.

The LEFT display can be dragged and docked on right, top and bottom.

To restore the default layout, select *Restore Panels Layout* entry from **Display** menu.

To switch between left/right and top/bottom layout, select the *Invert Panels Position* entry, while to switch the panels (left to right or top to bottom and vice versa), select *Switch Panels* entry.

3.7. Rhythm & Beat Editor Viewer

The *Rhythm & Beat Editor Viewer* is an enhanced *Continuous ECG Viewer* that shares the very same display features and, in addition, allows the interaction with the ECG tracing.

It is thus possible to select one or more ECG beats and change their beat annotation label, modify the detection point of an ECG beat or to manually enter or delete Noise Regions or Rhythm Annotations.

For the various annotation display features, refer to sections 3.4.1 to 3.4.4 of the *Continuous ECG Viewer*. For the "Display Configuration" refer to section 3.4.5, starting on page 18.

In *Rhythm & Beat Editor*, all major actions that can be performed with the mouse are also accessible by the keyboard. To configure keyboard key combination, refer to section 3.29.4, on page 161.

In *Rhythm & Beat Editor Viewer* a beat attractor, in green color, allows to perform an action on a single beat or on a multiple beat selection.

If Beat editing is performed after Rhythm analysis has run, there could be erroneous Rhythm annotations still visualized.

3.7.1. Beat & Rhythm Editing

3.7.1.1. Editing on single ECG beat

By clicking the primary mouse-button on a single beat, the context menu (Figure 25) is displayed where it is possible to:

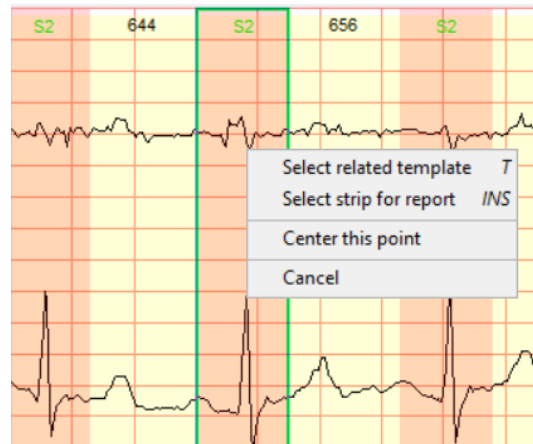
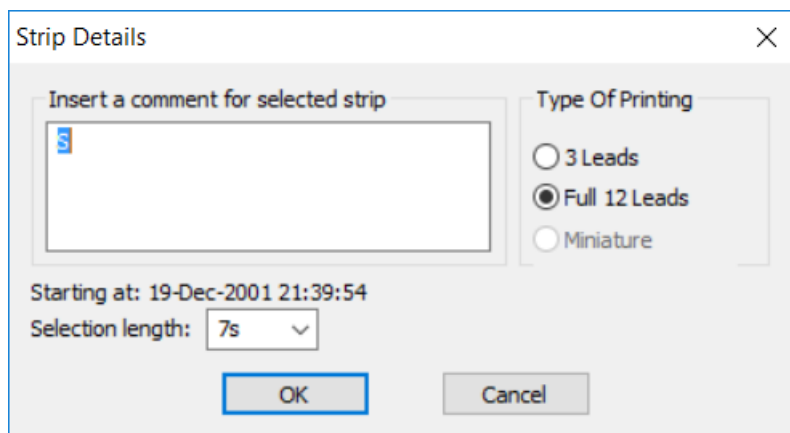


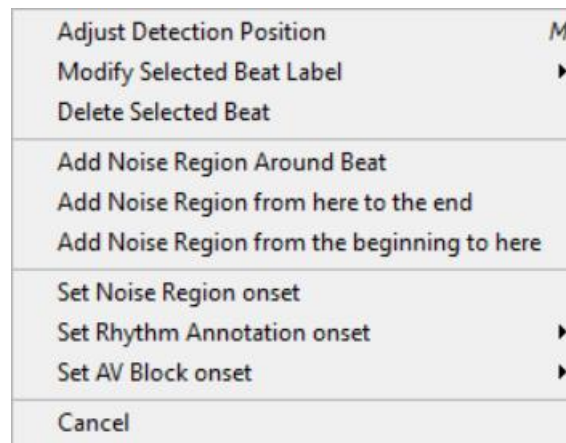
Figure 25 – Context Menu for primary-mouse click on a single ECG beat

- show the template related to the selected ECG beat
- select the ECG strip for report
 - in this case an ECG strip of 7s length centered on the selected beat will be flagged to be included in the report. The user can then edit the default strip label, the beat label, select the desired layout between 12 Leads and 3 Leads (II, V2 and V5) and, if needed, increase the strip length.



- Center the current view to the selected beat's position, selecting the "Center this point" entry.

Clicking the secondary mouse-button on a single beat, it is possible to:



- adjust the beat detection position, selecting the “Adjust Detection Position” entry. The “Adjust Detection Position” dialog is prompted where the beat detection position can be edited as shown in Figure 26. In the dialog box, it is also possible to adjust the display organization for a more precise caliper editing, but the default is the very same display layout than the *Continuous ECG Viewer* or *Rhythm & Beat Editor*.



Figure 26 – Manual adjustment of single ECG beat detection position

- modify selected beat label
 - the list of available beat categories is displayed (Figure 27), these being:
 - N – Normal Beat
 - V – Ventricular Beat
 - S – Supraventricular Beat
 - C – Calibration Pulse
 - B – Beat with Bundle Branch Block

- P – Paced Beat
- E – Ventricular Escape Beat
- F – Fusion Beat
- U – Unknown Beat
- X – Artifact

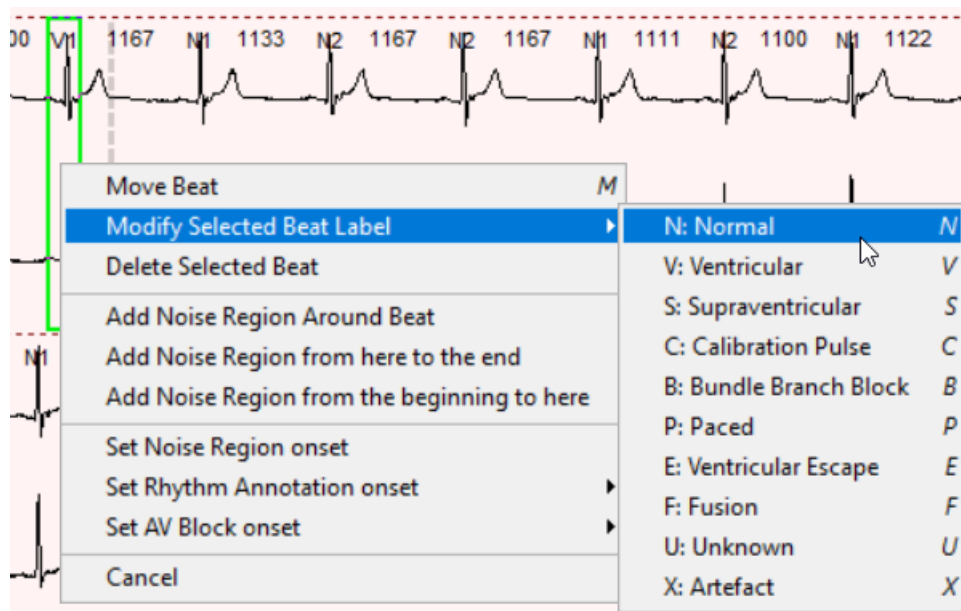
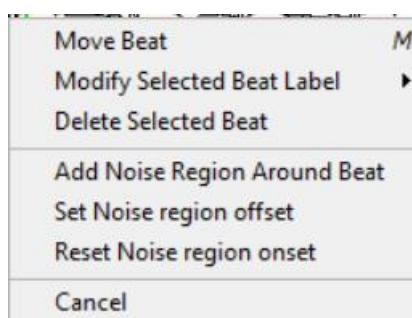


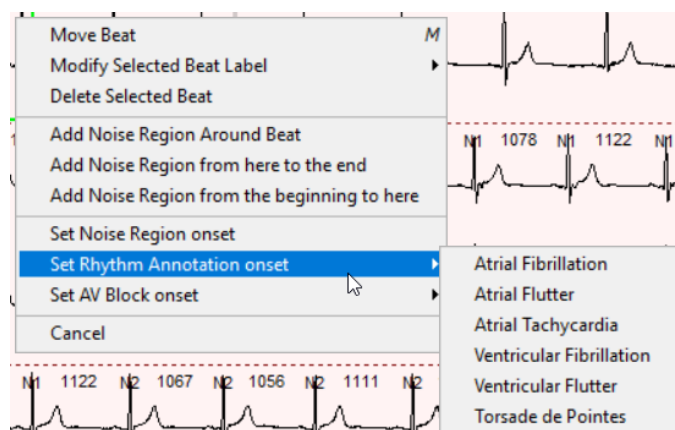
Figure 27 – Context Menu to modify the ECG beat label

- delete selected beat
- add Noise Region (a noise region will be entered, centered on the selected beat and extended in both right and left direction to the first valid beat)
- Add a Noise Region starting from the beginning of the ECG recording to the selected beat's position
- add a Noise Region starting from the selected beat and ending at the end of the ECG recording, to be used in case leads are detached while the recording is still ongoing
- add Noise region by selecting the onset and afterward selecting the offset (or resetting the noise region addition), via context menu displayed upon clicking the secondary mouse-button on a beat. The option of resetting the previously entered noise onset is also available.



- set the start point of a new rhythm annotation selecting the "Set Rhythm Annotation onset" entry and selecting the related annotation between those that can be manually entered, namely:
 - Atrial Fibrillation

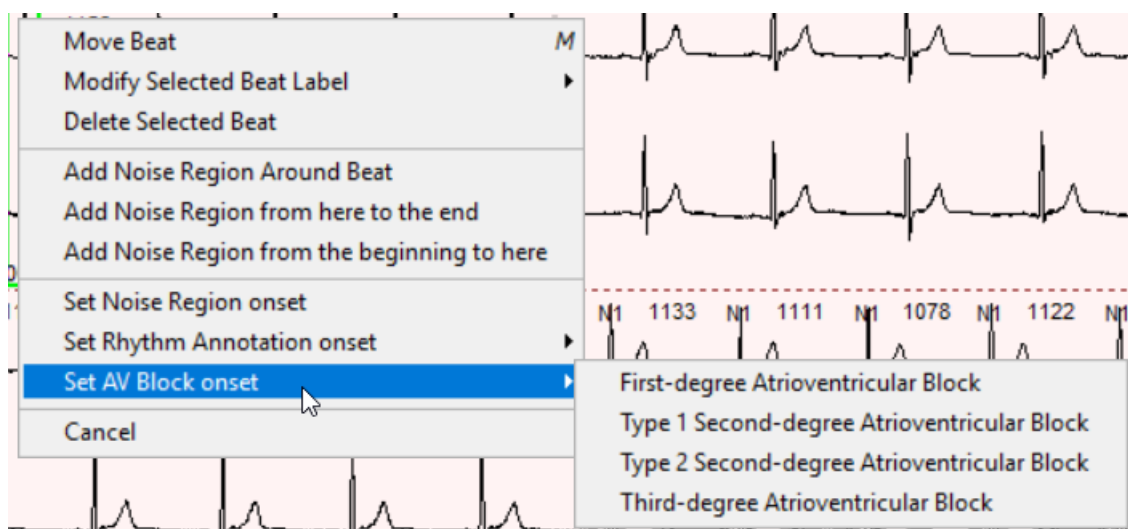
- Atrial Flutter
- Atrial Tachycardia
- Ventricular Fibrillation
- Ventricular Flutter
- Torsade de Pointes



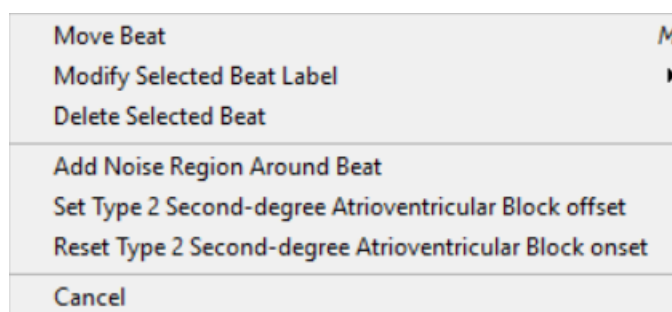
Then the user will have to select the offset of the Rhythm annotation, as reported here below where Atrial Fibrillation onset had been previously selected. The option of resetting the previously entered onset is also available.



- set the start point of an AtrioVentricular Block annotation selecting the "Set AV Block onset" entry and selecting the correct entry between:
 - First-degree Atrioventricular Block
 - Type 1 Second-degree Atrioventricular Block
 - Type 2 Second-degree Atrioventricular Block
 - Third-degree Atrioventricular Block

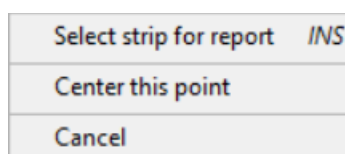


Then the user will have to select the offset of the atrioventricular block. The option of resetting the previously entered AVB onset is also available.

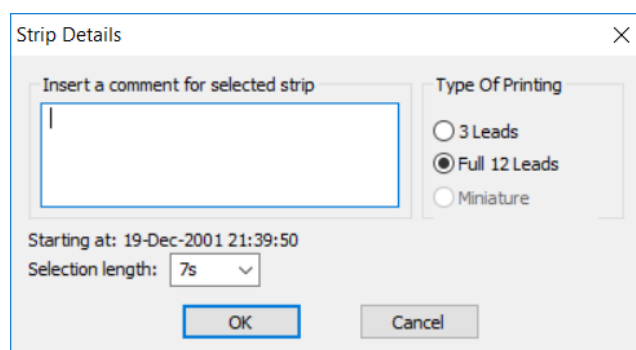


3.7.1.2. Editing on the ECG signal & Entering a New ECG Beat

By clicking the primary mouse-button on the ECG signal (with a certain distance from an existing ECG beat), the following context menu is displayed where it is possible to:



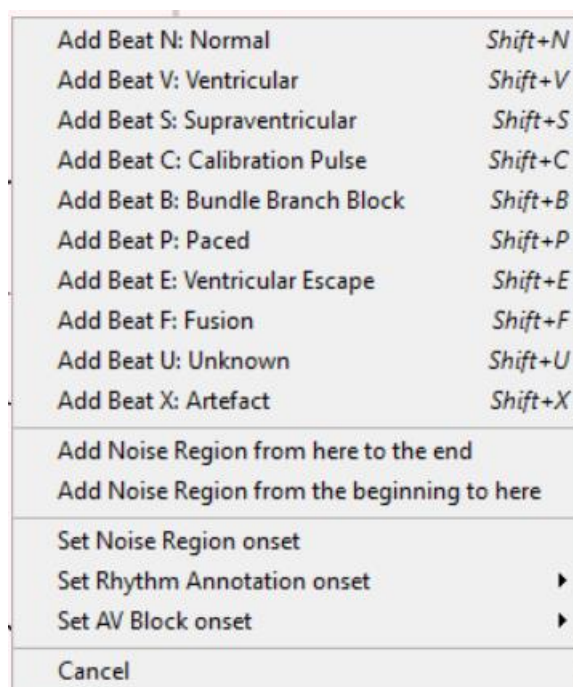
- select the ECG strip for report
 - in this case an ECG strip of 7s length centered on the selected beat will be flagged to be included in the report. The user can then enter a strip label, select the desired layout between 12 Leads and 3 Leads (II, V2 and V5) and, if needed, increase the strip length.



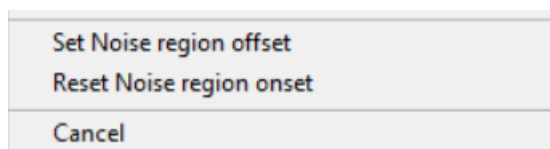
- Center the current view to the selected beat's position, selecting the "Center this point" entry.

Clicking the secondary mouse-button on the ECG signal (with a certain distance from an existing ECG beat), the following context menu is displayed where it is possible to:

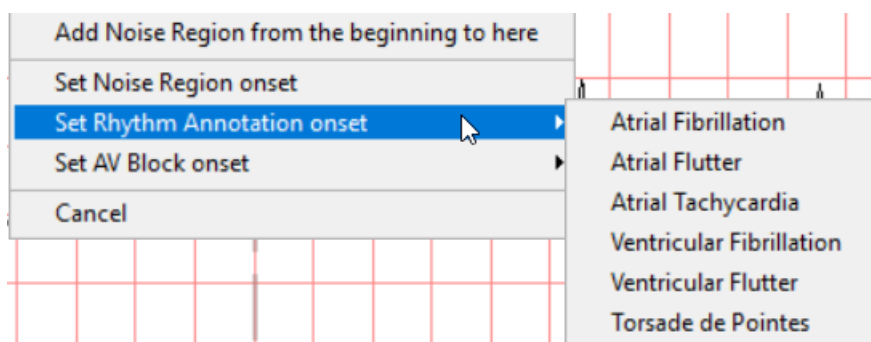
- add a new ECG beat with a given label
 - the list of available beat categories is displayed (Figure 27), these being:
 - N – Normal Beat
 - V – Ventricular Beat
 - S – Supraventricular Beat
 - C – Calibration Pulse
 - B – Beat with Bundle Branch Block
 - P – Paced Beat
 - E – Ventricular Escape Beat
 - F – Fusion Beat
 - U – Unknown Beat
 - X – Artifact



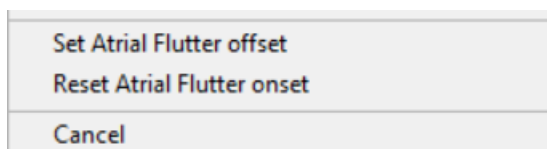
- add a Noise Region starting at the beginning of the ECG recording to the selected position
- add a Noise Region starting at the selected position and ending at the end of the ECG recording
- add Noise region by selecting the onset and afterward selecting the offset (or resetting the noise region addition), via context menu displayed upon clicking the secondary mouse-button anywhere on the ECG signal. The option of resetting the noise previously entered onset is also available.



- set the start point of a new rhythm annotation selecting the "Set Rhythm Annotation onset" entry and selecting the related annotation between those that can be manually entered, namely:
 - Atrial Fibrillation
 - Atrial Flutter
 - Atrial Tachycardia
 - Ventricular Fibrillation
 - Ventricular Flutter
 - Torsade de Pointes

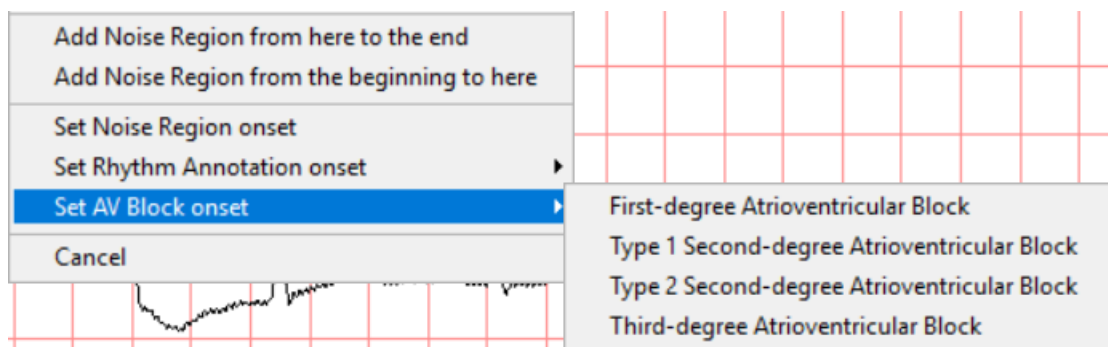


Then the user will have to select the offset of the Rhythm annotation, as reported here below where Atrial Flutter onset had been previously selected. The option of resetting the previously entered onset is also available.

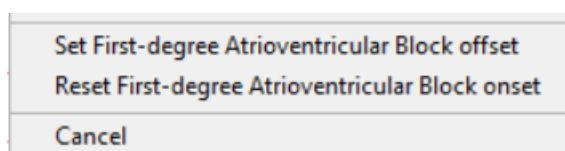


- set the start point of an AV Block annotation selecting the "Set AV Block onset" entry and selecting the correct entry between:
 - First-degree Atrioventricular Block
 - Type 1 Second-degree Atrioventricular Block
 - Type 2 Second-degree Atrioventricular Block

- Third-degree Atrioventricular Block



Then the user will have to select the offset of the atrioventricular block. The option of resetting the previously entered AVB onset is also available.



3.7.1.3. Editing a contiguous selection of ECG Beats

Selecting a contiguous group of ECG beats with the primary mouse-button, the following context menu (Figure 28) is displayed, where it is possible to:

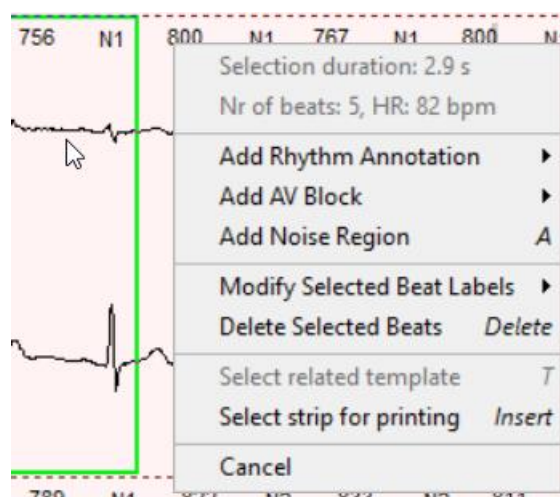


Figure 28 – Context Menu for a selection of multiple contiguous ECG beats. On the top of the menu are reported the information about the selection such as the duration of the selection, the number of the involved beats and the heart rate

- modify the label of the selected beats
 - the list of available beat categories: the same as the one for single-beat editing, displayed in Figure 27, on page 32.
- delete selected beats
- add Noise Region on the selected beats
- add a Rhythm Annotation
 - the rhythm annotations that can be manually added are:

- Atrial Fibrillation
- Atrial Flutter
- Atrial Tachycardia
- Ventricular Fibrillation
- Ventricular Flutter
- Torsade de Pointes

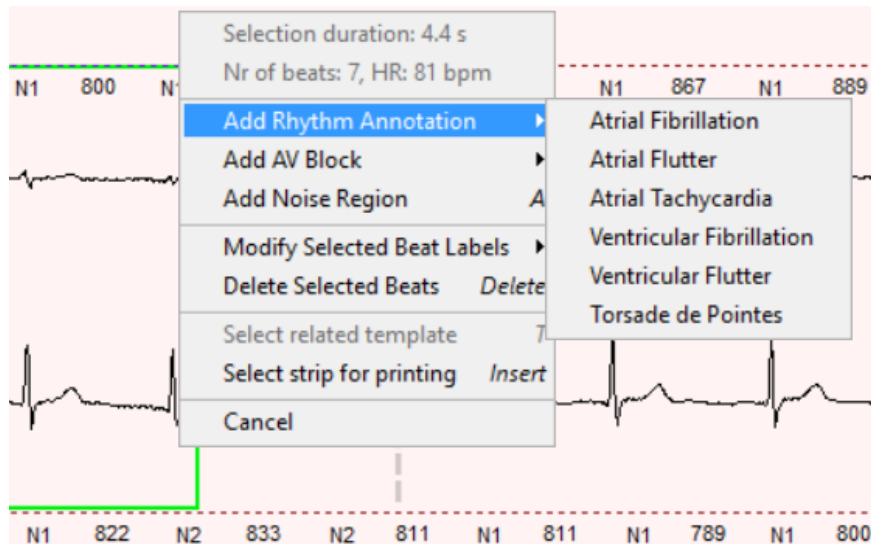


Figure 29 – Context Menu for manual insertion of Rhythm Annotations

- add an Atrioventricular Block annotation between:
 - First-degree Atrioventricular Block
 - Type 1 Second-degree Atrioventricular Block
 - Type 2 Second-degree Atrioventricular Block
 - Third-degree Atrioventricular Block
- select the ECG strip for report
 - in this case an ECG strip of 7s length (or multiple of 7s, in case an annotation longer than 7s is selected) centered on the selected annotation will be flagged for printing. In case of an annotation longer than 42s, the strip will be truncated to a length of 42s. The user can then edit the default strip label, the annotation type, select the desired layout between 12, 3 Leads (II, V2 and V5) and miniature (only in case an annotation longer than 7s is selected) and edit the strip length.
 - in this case an ECG strip of 7s length (or multiple of 7s, in case an annotation longer than 7s is selected, for a maximum of 42s) centered on the selected annotation will be flagged for printing. The User can specify a label for the strip, although a default label is predefined, and select the desired layout between 12, 3 Leads (II, V2 and V5 in case of 12 lead continuous ECG recording) and miniature, in case an annotation longer than 7s is selected, as shown in Figure 18. If the selected beat-selection is longer than 14s, the default layout will be set to miniature.

3.7.1.4. Selection of noncontiguous ECG Beats

It is possible to select noncontiguous ECG beats via primary mouse button, keeping the CTRL key down.



Figure 30 – Context Menu for a selection noncontiguous multiple ECG beats.

Then, by clicking the secondary mouse button it is possible to:

- modify the label of the selected beats
 - the list of available beat categories: the same as the one for single-beat editing, displayed in Figure 27, on page 32.
- delete selected beats

3.7.1.5. Action on Rhythm Annotations

Clicking the primary mouse-button on a Rhythm annotation, a context menu is displayed (as shown in Figure 31), where it is possible to:

- Go to the beginning of the selected Rhythm Annotation (the entry is available only when the starting point of the selected annotation is not displayed in the current displayed ECG): the current ECG view is scrolled to allow the starting point of the selected annotation to be displayed.
- Go to the end of the selected Rhythm Annotation (the entry is available only when the end of the selected annotation is not displayed in the current displayed ECG): the current ECG view is scrolled to allow the ending point of the selected annotation to be displayed.

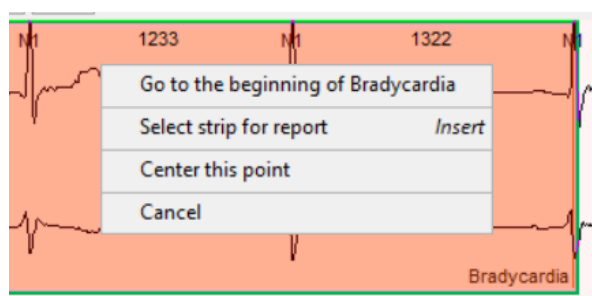


Figure 31 – Context Menu for actions on a Rhythm Annotation, on primary mouse button click

- select the ECG strip for report
 - in this case an ECG strip of 7s length (or multiple of 7s, in case an annotation longer than 7s is selected) centered on the selected annotation will be flagged to be included in the report. In case of an annotation longer than 42s, the strip will be truncated to a length of 42s. The user can then edit the default strip label, the annotation type, edit the desired layout between 12, 3 Leads (II, V2 and V5) and miniature (only in case an annotation longer than 7s is selected) and edit the strip length.
- center the ECG display to the selected position

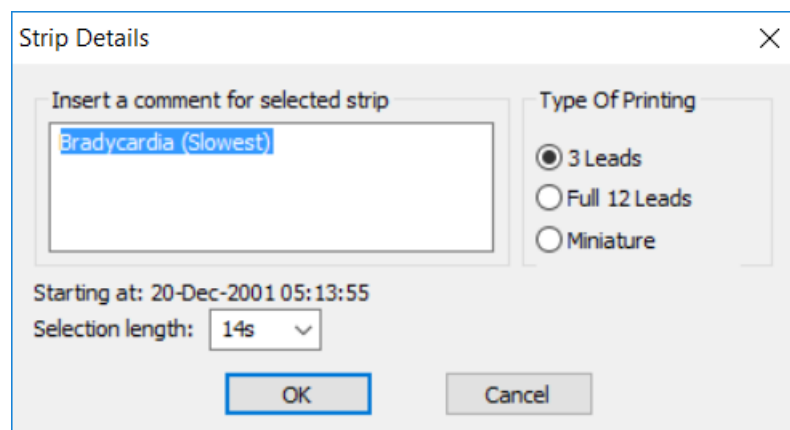
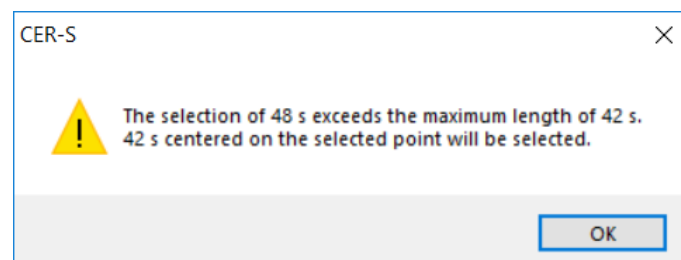


Figure 32 – "Strip Details" dialog, allowing to edit Strip label (preset to the Rhythm Annotation type), select the strip layout and edit the strip length.

If the selected rhythm is longer than 42 seconds and the strip layout is not set to miniature, a message box alerting the user of the large selection is shown.



Clicking the secondary mouse-button on a Rhythm annotation, a context menu is displayed where it is possible to (refer to section 3.7.1.2 for more details):

- delete selected Rhythm Annotation
- rename ATA Rhythm Annotation (Atrial Fibrillation, Atrial Flutter and Atrial Tachycardia) to another ATA annotation
- add a new ECG beat with a given label
- add a Noise Region starting at the beginning of the ECG recording to the selected position
- add a Noise Region starting at the selected position and ending at the end of the ECG recording
- set the start point of a Noise region by selecting the "Set Noise Region onset" entry
- set the start point of a new rhythm annotation selecting the "Set Rhythm Annotation onset" entry

- set the start point of an AV Block annotation selecting the “Set AV Block onset” entry

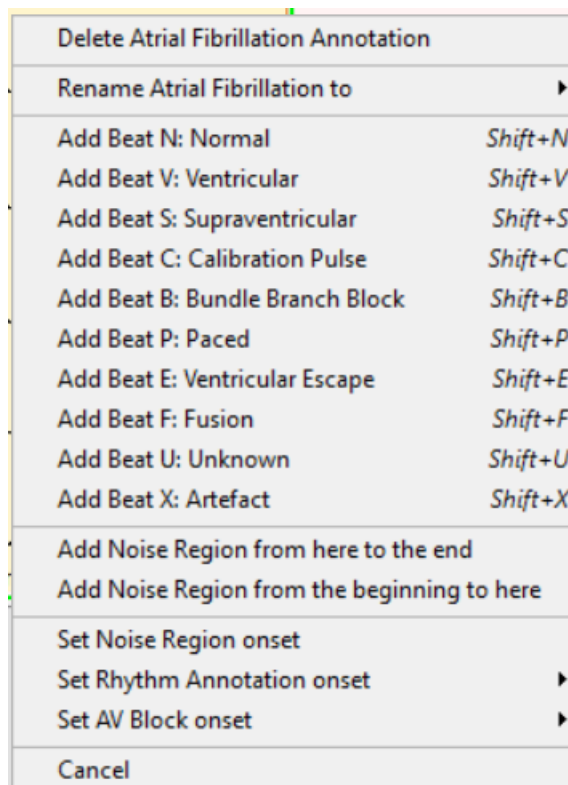


Figure 33 – Context Menu for actions on a Rhythm Annotation, on secondary mouse button click

3.7.1.5.1. Manipulation of Rhythm Annotations

It is possible to reduce or widen a rhythm annotation clicking and dragging the primary mouse-button on a selection of ECG beats.

- To widen a rhythm annotation, the selection must start from the first (or the last) beat of the annotation and end outside it (as shown in Figure 34). In this case, the context menu provides the option to widen the annotation. Similarly it is possible to make a selection starting outside the annotation and end on the first (or the last) beat of the annotation.

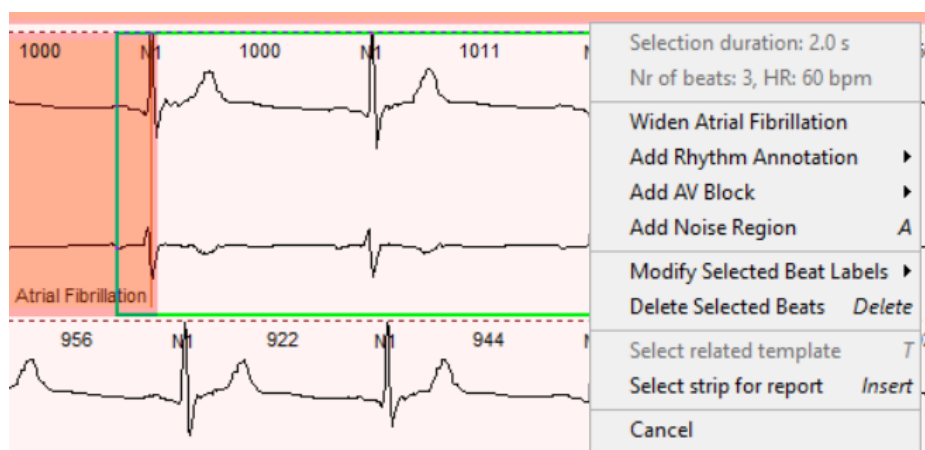


Figure 34 – Selection of beats which enable the “Widen Rhythm Annotation” entry in the context menu

- To reduce a rhythm annotation, the selection must be entirely within the annotation itself (as shown in Figure 35). In this case the context menu presents an option to remove a section of the annotation.

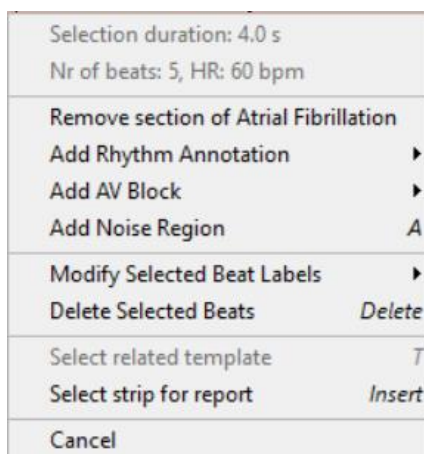


Figure 35 – Selection of beats which enable the "Remove Section of Rhythm Annotation" entry in the context menu

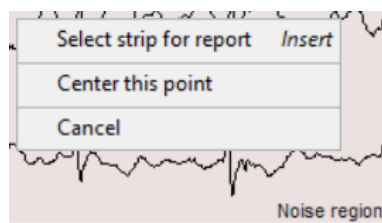
The rhythm annotations which can be widened or reduced is limited to those that can be manually added :

- Atrial Fibrillation
- Atrial Flutter
- Atrial Tachycardia
- Ventricular Fibrillation
- Ventricular Flutter
- Torsade de Pointes

3.7.1.6. Action on Noise Regions

Clicking the primary mouse-button on a Noise Region, a context menu is displayed enabling to:

- Go to the beginning of the Noise Region (the entry is available only when the starting point of the selected region is not displayed in the current displayed ECG)
- Go to the end of the selected Noise Region (the entry is available only when the end of the selected region is not displayed in the current displayed ECG)

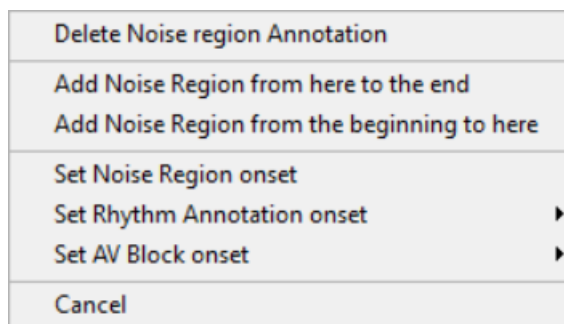


- select the noise region for report
 - in this case an ECG strip of 7s length (or multiple of 7s, in case a noise region longer than 7s is selected) centered on the selection point will be flagged to be included in the report. In case of an annotation longer than 42s, the strip

will be truncated to a length of 42s. The user can then edit the default strip label, the annotation type, edit the desired layout between 12, 3 Leads (II, V2 and V5) and miniature (only in case an annotation longer than 7s is selected) and edit the strip length.

- center the ECG display to the selected position


Clicking the secondary mouse-button on a Noise Region, a context menu is displayed allowing, among other things, to delete it.



3.7.2. Edited status

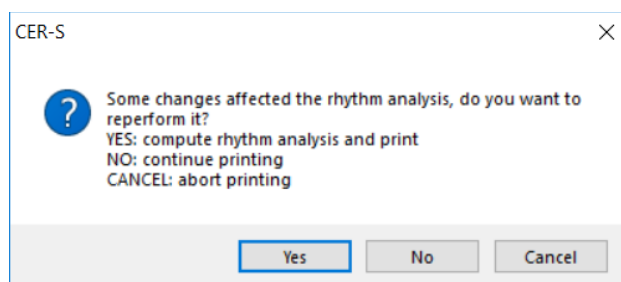
When beat detection is performed, the change of status is reported in CER-S status bar as "BD". In case modifications are made by the user the new status is reported in CER-S status bar "BDe".

Similarly, when rhythm analysis is performed, the change of status is reported in CER-S status bar as "RA". In case a modification made by the user can alter the analysis, a visual alert reporting that the analysis could be obsolete ("RA Obsolete") is displayed on the title bar and the new status is reported in CER-S status bar "RA(obs)", refer to section 3.3.3 for all the details on Analysis status.

 CER-S - N 6 (AJK-04a.ecg) - Subject: AJK - ID: 4-a - DOR: 19 Dec 2001-(RA Obsolete)

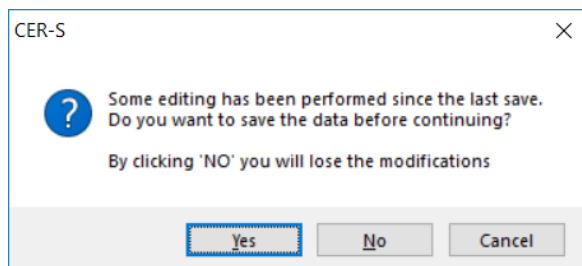
When the analysis is obsolete, if the user proceeds in printing the report (see section 3.27), a message box is prompted informing the user that rhythm annotations are obsolete and providing three options:

- recompute rhythm analysis before printing the report – clicking YES
- proceed with printing the report, without recomputing rhythm analysis –NO
- cancel printing - CANCEL



If editing is performed from the original native record annotation, the new status will be "Oe".

Whenever editing is performed, manual modifications are made and not yet saved in the ACEA session file, a visual alert '*' is displayed on the title bar, indicating that editing has been performed and not yet saved. If the user attempts to close the software or load a new record, the following warning message is prompted:



The visual alert is no longer shown upon saving the ACEA session file.

3.7.3. Edit Settings



Clicking on the "Edit Settings" button, the "Rhythm & Beat Editor Settings" dialog is opened. Refer to section 3.4.10 for "Continuous ECG Viewer Settings" which are identical.

3.7.4. Events & Beats Review mode



Clicking this button allows to activate the Rhythm annotations & Beats Review mode that simplifies the events display of Rhythm & Beat Editor in case of selection of ECG Beats, Rhythm annotation events and HR events.

Here the list of Rhythm & Beat Editor display modification in the various selections:

- ECG Beats
 - beats and noise regions are displayed, while rhythm annotation and HR events are hidden
 - Rhythm annotations cannot be entered

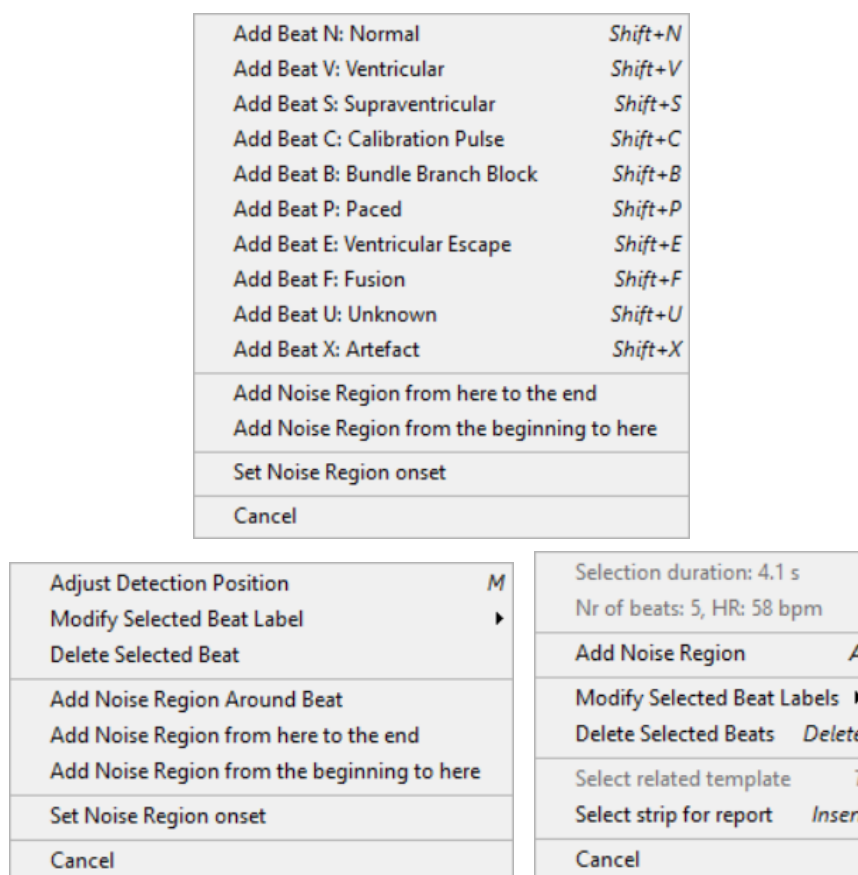


Figure 36 – Context menus in Rhythm & Beat Editor in case of Beats Review mode, by clicking the secondary mouse button within two beats (top image), clicking on a beat (bottom left image) and selection of contiguous beats (bottom right image)

- Rhythm annotations
 - beats, noise regions and selected rhythm annotation type are displayed, while the other rhythm annotation types and HR events are hidden
 - ECG beats cannot be selected, green rectangles are hidden
 - Strips cannot be selected for the report

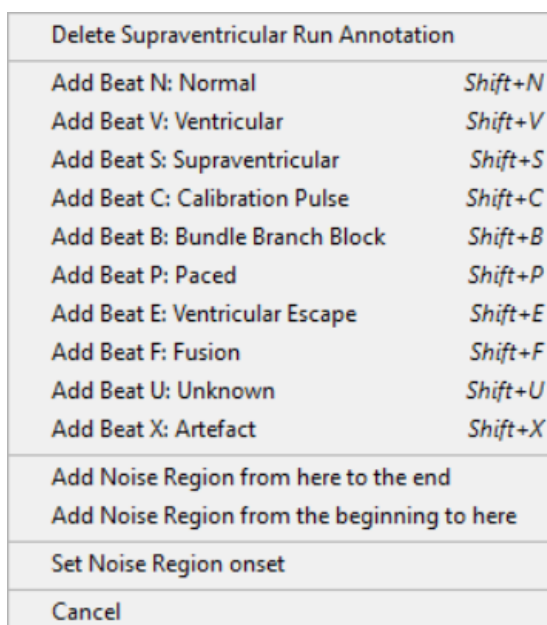


Figure 37 – Rhythm & Beat Editor Context menu, in case of Events Review mode, by clicking the secondary mouse button anywhere on the display, with Atrial Fibrillation annotations selection

- HR events
 - beats, noise regions and HR events are displayed, while all rhythm annotations are hidden
 - ECG beats cannot be selected, green rectangles are hidden
 - Strips cannot be selected for the report

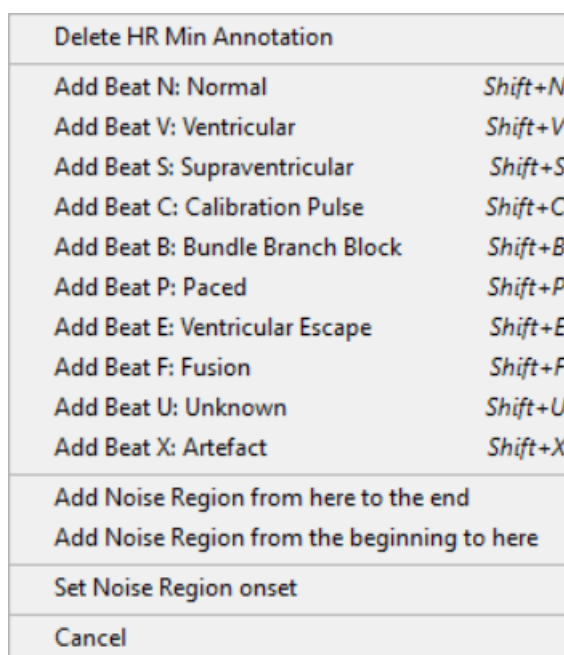


Figure 38 – Rhythm & Beat Editor Context menu, in case of HR Events Review mode, by clicking anywhere on the display, with HR Max event selection

Events & Beats Review mode can also be activated in the Rhythm & Beat Editor settings (section 3.4.10), by enabling the related check-box.

☐ Enable Rhythm Annotations & Beats Review Mode

Note that in case of Beats Review mode active, the strip dialog is not prompted upon selecting the "Select strip for report entry", while in case of Rhythm annotations Review mode active, as EG beat cannot be selected, ECG strips cannot be entered.

As Rhythm annotations & Beat Review mode deeply simplifies the events display, visualizing only certain ECG annotations or ECG Beats, the cardiologist may be induced to erroneously fail to assess all the events.

If Rhythm annotations Review mode is active, selection and editing of ECG beats is disabled.

3.7.5. RBE in Multiday analysis

In case of multiday recording, beat information is not reported in the Rhythm & Beat Editor and thus it is only possible to enter Rhythm annotation and Noise Regions by specifying the event onset and then indicate the offset.

By clicking the primary mouse-button, the context menu (Figure 39) is displayed where it is possible to:

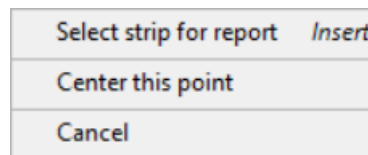
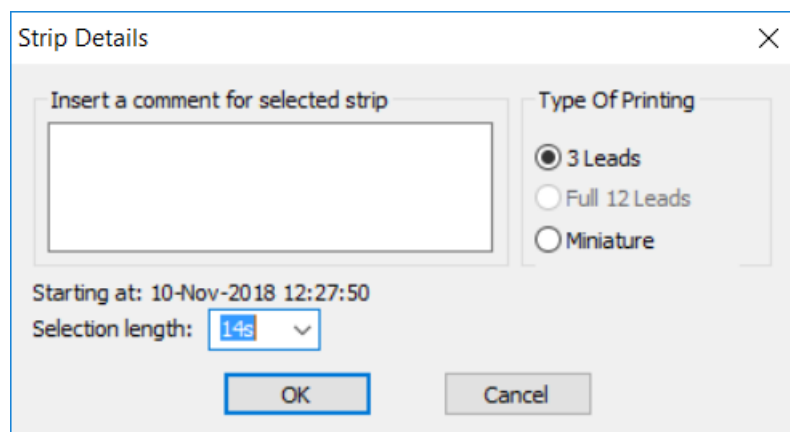


Figure 39 – Context Menu for primary-mouse click on a multiday recording

- select the ECG strip for report
 - in this case an ECG strip of 7s length centered on the selected point will be flagged to be included in the report. The user can then enter a strip label, select the desired layout between 12 Leads (in case of a 12 leads recording) and 3 Leads (II, V2 and V5 in case of 12 leads recording or the first three leads) and increase the strip length. In case the selection length is greater than 7s, a miniature layout can also be selected.



- Center the current view to the selected beat's position, selecting the "Center this point" entry.

By clicking the secondary mouse-button, the context menu (Figure 40) is displayed where it is only possible to:

- add a Noise Region starting at the beginning of the ECG recording to the selected position
- add a Noise Region starting at the selected position and ending at the end of the ECG recording
- set the start point of a Noise region by selecting the "Set Noise Region onset" entry
- set the start point of a new rhythm annotation selecting the "Set Rhythm Annotation onset" entry and selecting the related annotation between those that can be manually entered case of multiday recording, namely:
 - Pause
 - Ventricular Tachycardia
 - Atrial Fibrillation
 - Atrial Flutter
 - Atrial Tachycardia
 - Ventricular Fibrillation

- Ventricular Flutter
- Torsade de Pointes

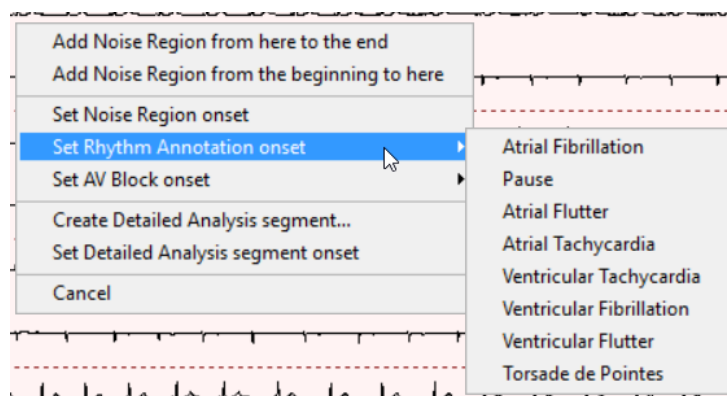
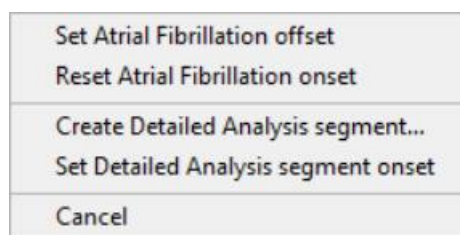
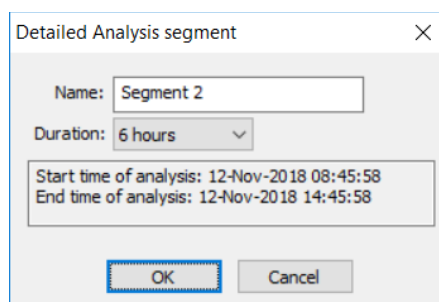


Figure 40 – Context menu for multiday recordings

Then the user will have to select the offset of the Rhythm annotation, as reported here below where Atrial Fibrillation onset had been previously selected. The option of resetting the previously entered onset is also available.

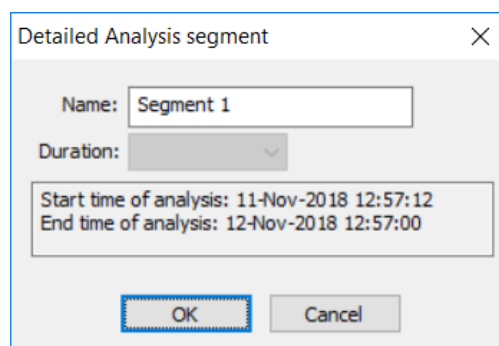


- set the start point of an AV Block annotation selecting the “Set AV Block onset” entry and selecting the correct entry between:
 - First-degree Atrioventricular Block
 - Type 1 Second-degree Atrioventricular Block
 - Type 2 Second-degree Atrioventricular Block
 - Third-degree Atrioventricular Block
- Enter a detailed analysis segment to cut and export in the current position (it will then be possible to perform standard Beat Detection and Rhythm analysis and that segment on a new CER-S session)

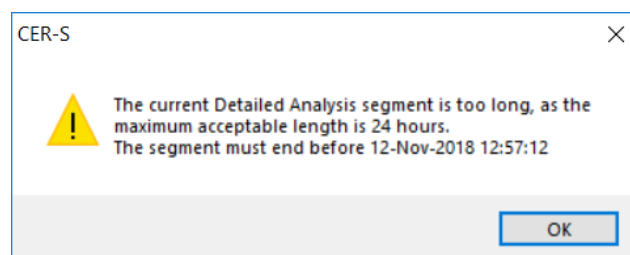


Here the user will have to specify:

- the name of the segment. This label will be placed in the Visit field of the exported record segment. In case a Visit label is already present in the current multiday continuous ECG recording, the Visit label of the exported record segment will be the concatenation of the two, divided by the text " - "
 - the length of the segment, between 1 and 24 hours.
- Set the onset of a detailed analysis segment to cut and export.
Then the user will have to select the offset of the detailed analysis segment and the following dialog will be prompted allowing to specify the name of the segment is displayed. This label will be placed in the Visit field of the exported record segment. In case a Visit label is already present in the current multiday continuous ECG recording, the Visit label of the exported record segment will be the concatenation of the two, divided by the text " - ".



The maximum length of detailed analysis segment is 24 hours and, in case of the segment between onset and offset is longer 24 hours, the following warning message will be prompted to inform the user to reduce the selection.



To export selected detailed analysis segments, select "Cut and Export Record" entry from File menu; segments will be exported in AMPS compressed format (ACecg).

3.7.5.1. Events & Beats Review mode

In case of active Event & Beats Review modality and an active selection of Atrial fibrillation events, in addition to the context menu entry described in the previous section, deletion and renaming of the Atrial fibrillation event will be available, as shown here below.

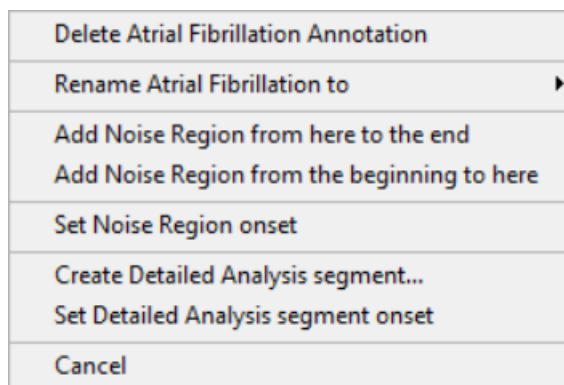


Figure 41 – Context menu for multiday recordings and active Review event mode

3.8. Analysis Window Viewer

The software includes a Viewer dedicated to the display of Analysis Windows (AWs): *Analysis Window Viewer*.

This Viewer is active only if:

- the loaded continuous ECG recording is in FDA HL7 XML v. 2 format and an AW element has been selected from the LEFT display Timepoint Window Navigator.
- the loaded continuous ECG recording is in ISHNE or MIT format, AWs have been loaded via the “aECG Generator” menu and an AW element has been selected from the LEFT display Timepoint Window Navigator.

Otherwise the “No AW selected” text will be visualized.

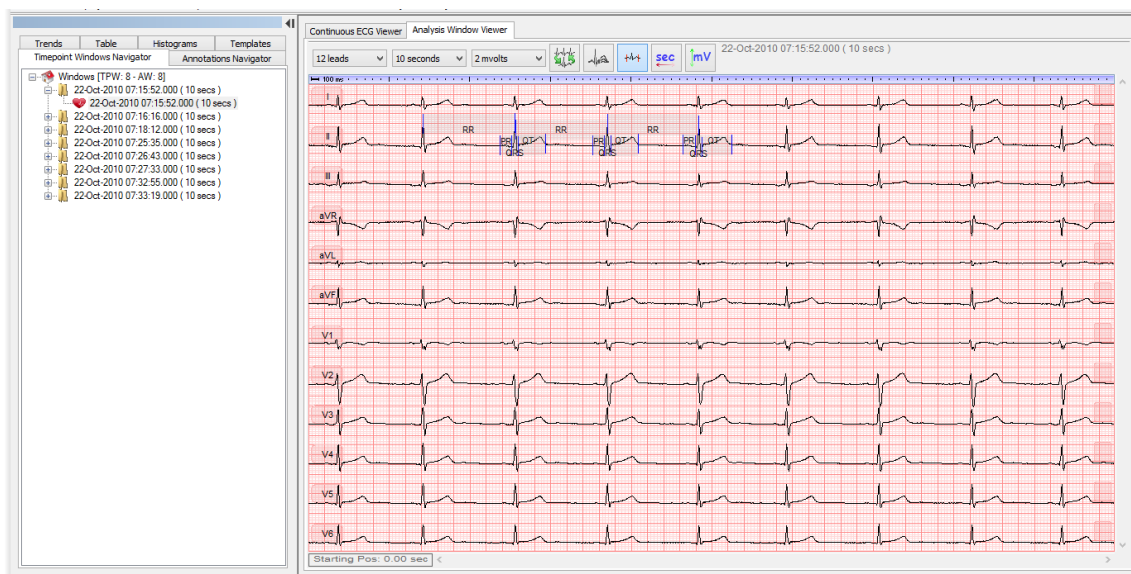
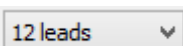


Figure 42 – Analysis Window Viewer 12 x 1 display – AW with annotations on lead II

The visualization customization options of the *Analysis Window Viewer* are mostly identical to those of the Continuous ECG Viewer (refer to sections 3.4 starting on page 13, and 3.4.5.2-3.29.1 for details) apart a few extra features described in the following sections.

3.8.1. Lead Display Customization – Rhythm Strip



As in the case of *Continuous ECG Viewer*, the number of leads to be displayed in the Viewer can be configured by selecting the desired number from the pull-down menu. In addition to the number of leads, there are four additional entries that can be selected, each mimicking one of the following standard paper ECG formats:

- 3 x 4: three leads per row in four columns (each lead is displayed for 2.5s),
- 6 x 2: six leads per row in two columns (each lead is displayed for 5s),
- 3 x 4 + Long Lead: three leads per row in four columns and long lead,
- 6 x 2 + Long Lead: six leads per row in two columns and long lead.

In addition to the ECG waveforms, the *Analysis Window Viewer* may also display annotations (if available).

The recording time offset of the leftmost part of the displayed waveforms is shown to the left of the scrollbar. If the ECG has not been scrolled, it will indicate "0.00 sec", as displayed in Figure 43.

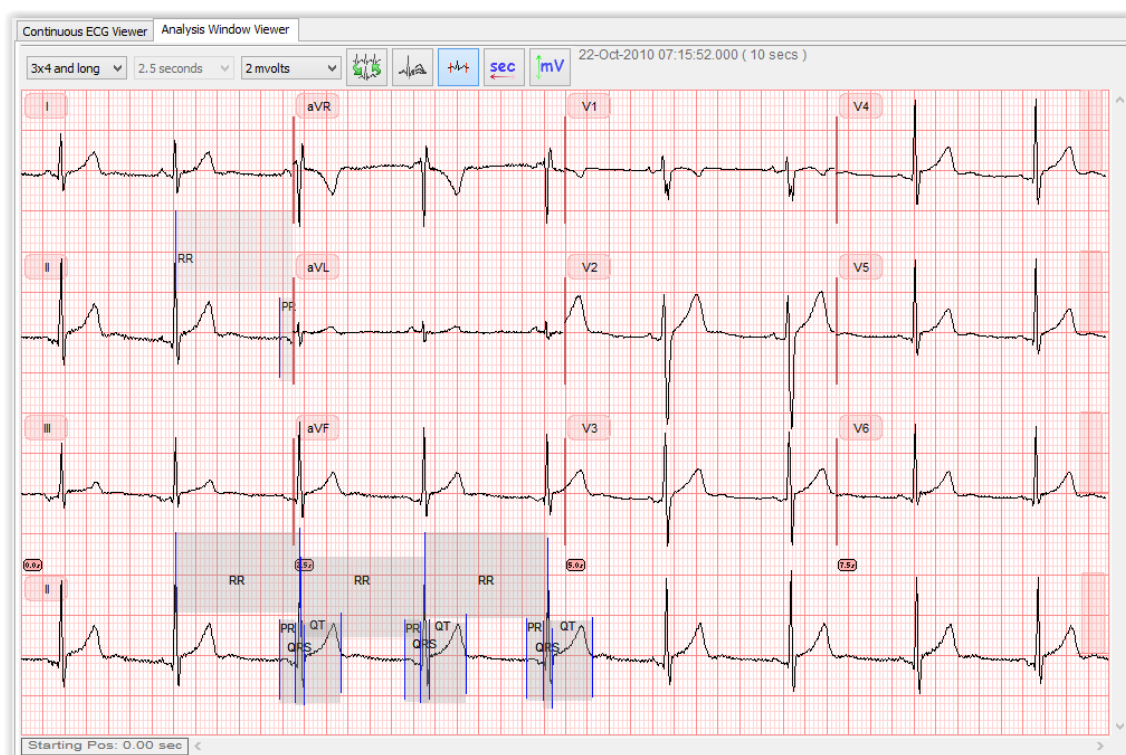


Figure 43 – Analysis Window Viewer 3 x 4 + long lead II display

3.8.2. ECG Beat Annotation Display



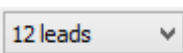
In the *Analysis Window Viewer*, the button allows to toggle on/off the display of the ECG measurement annotations.

3.8.3. Representative Beat display



The button helps to toggle between the Rhythm and the Representative Beats display.

3.8.3.1. Lead Display Customization – Representative Beats



The number of leads to be displayed in the Viewer can be configured by selecting the desired number from the pull-down menu. In addition to the number of leads, there are four additional entries that can be selected, each mimicking one of the following standard paper ECG formats:

- 3 x 4: three leads per row in four columns,
- 6 x 2: six leads per row in two columns,
- 3 x 4 + Overlap: three leads per row in four columns and Superimposed display,
- 6 x 2 + Overlap: six leads per row in two columns and Superimposed display.

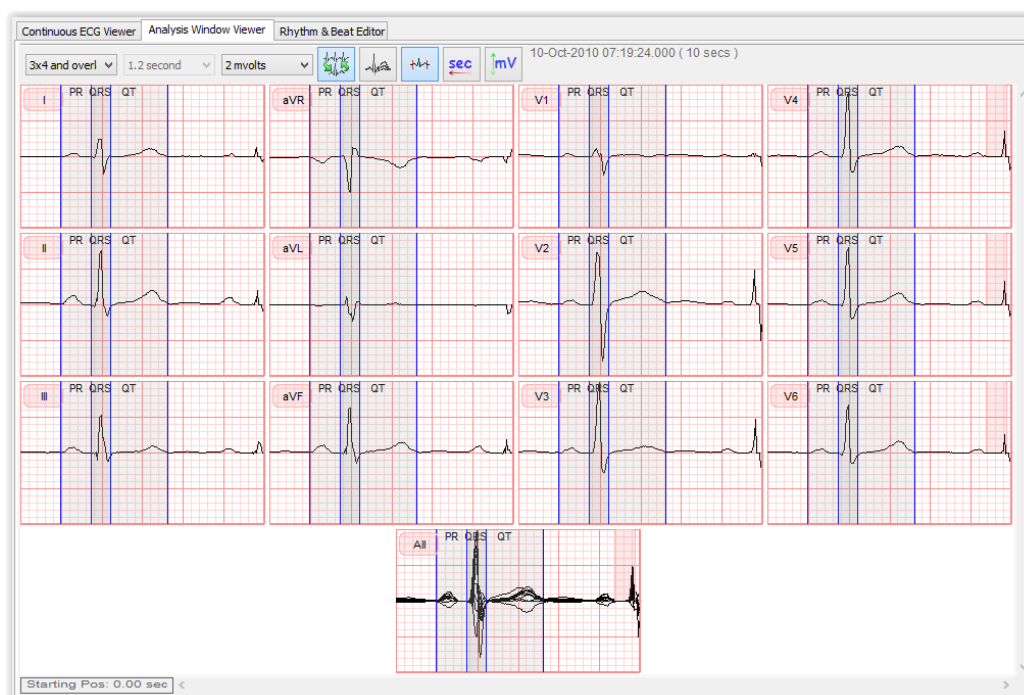


Figure 44 – Analysis Window Viewer, Representative Beats display in 3 x 4 + Overlap format; annotations are available on the Global (SMB)

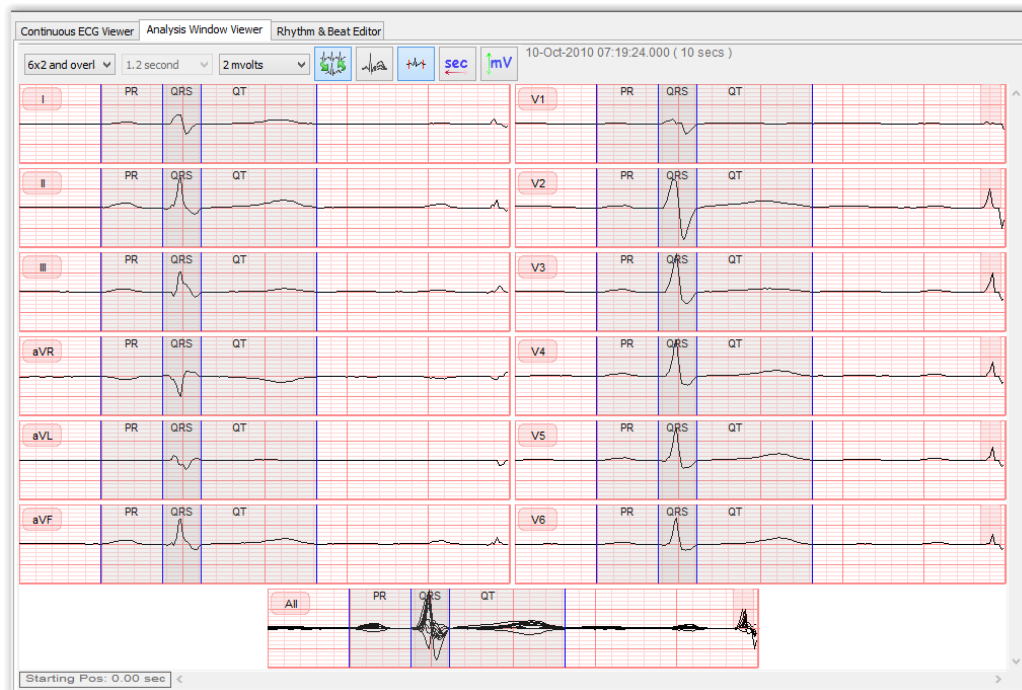


Figure 45 – Analysis Window Viewer, Representative Beats display in 6 x 2 + Overlap format; annotations are available on the Global (SMB)




3.9. Timepoint Window Navigator

The software includes a module that allows the navigation of Timepoint Windows and Analysis Windows listings: *Timepoint Window Navigator*.

This module is active only if:

- the loaded continuous ECG recording is in aECG FDA HL7 XML v. 2 format and it contains at least a Timepoint Window or an AW.
- the loaded continuous ECG recording is in ISHNE or MIT format and at least a Timepoint Window or an AW has been loaded via the “aECG Generator” menu.

This module is structured as a tree (see Figure 46), with three levels:

- first level, identified with the icon 
 - provides a summary of the available Timepoint Windows (TPW) and Analysis Windows (AW),
 - provides a summary of the available Protocol Events entries
- second level, identified with the icon 
 - indicates a given TPW. Each TPW is identified by its start date/time and the duration in minutes, in between round brackets
 - indicates a given Protocol Event with its Label and time
- third level, identified with the icon , indicates a given AW. Each AW is identified by its start date/time and the duration, in seconds, between round brackets.

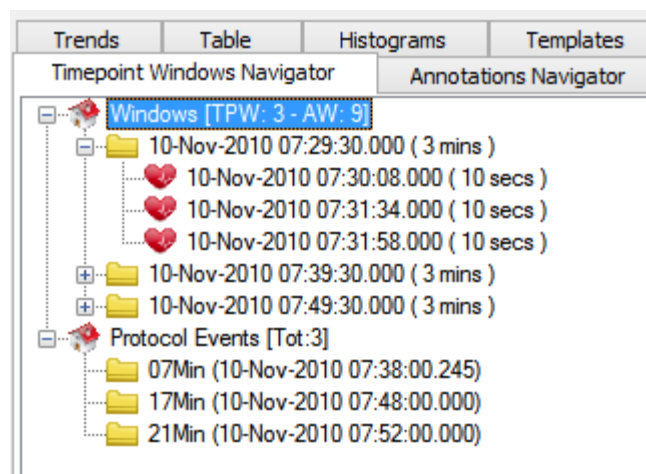


Figure 46 – Timepoint Windows Navigator – example with 3 TPWs and 9 AWs, 3 per TPW and 3 Protocol Events

Clicking the first level icon is not linked to any display changes. On the other hand by clicking on a TPW icon, the *Continuous ECG Viewer* or *Rhythm & Beat Editor* will be synchronized to visualize the start time of the selected TPW in the center of the Viewer (refer to Figure 47).

By clicking on a protocol event entry, both the *Continuous ECG Viewer* and the *Rhythm & Beat Editor* are synchronized to display the event in the center of the Viewer.

By clicking on an AW icon, the *Analysis ECG Viewer* is displayed, visualizing the selected Analysis Window (refer to Figure 48).

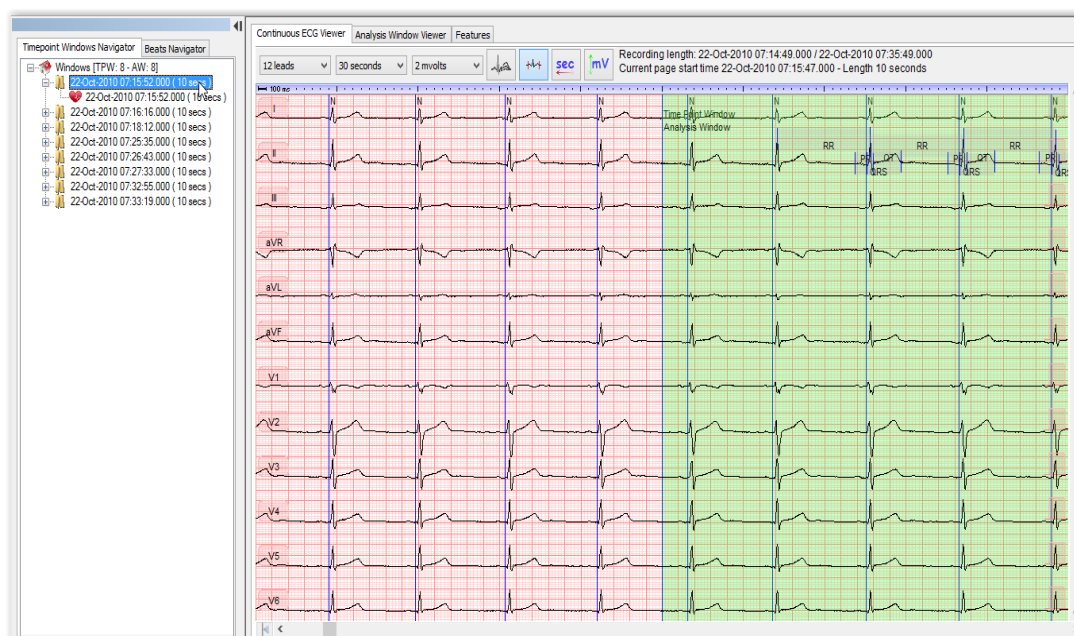


Figure 47 – Timepoint Windows Navigator – Time synchronization of the Continuous ECG Viewer by clicking on a TPW

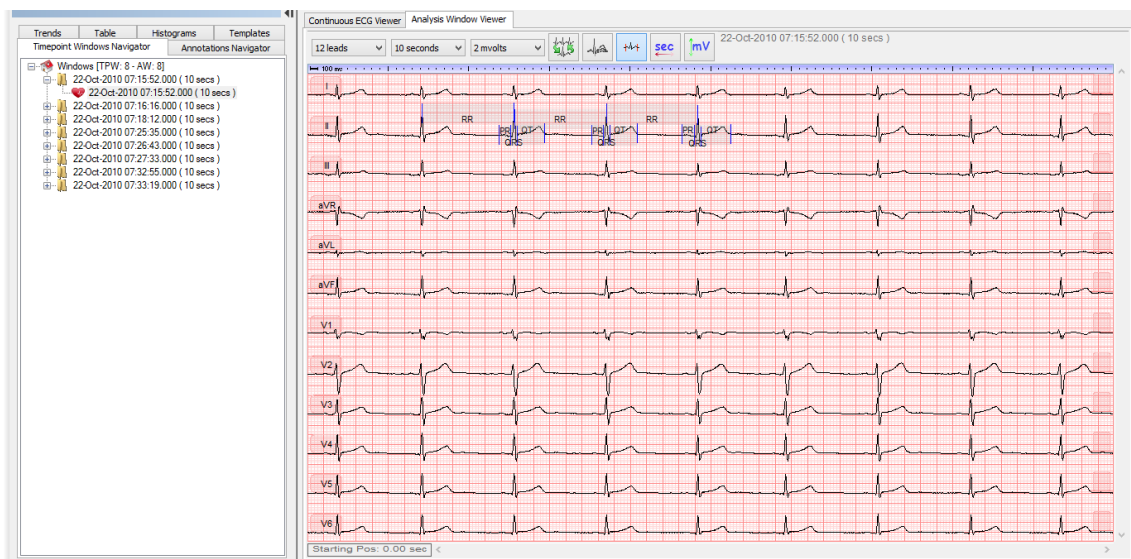


Figure 48 – Timepoint Windows Navigator – Analysis ECG Viewer is displayed by clicking on an AW

3.10. Annotations Summary

When a continuous ECG recording is loaded along with its ECG beat annotations file or a session is restored, the Annotations Summary displays an interactive summary of all the ECG Beat annotations, Rhythm and Noise annotations.

3.10.1. ECG Beat Annotation details

The overall number of ECG Beats and the overall time is reported on top, and then all the ECG beat types are reported with their frequency.

It is then possible to “maximize” each beat type node and see the element-listings (date/time of the ECG beat) of all ECG beats belonging to a given classification label.

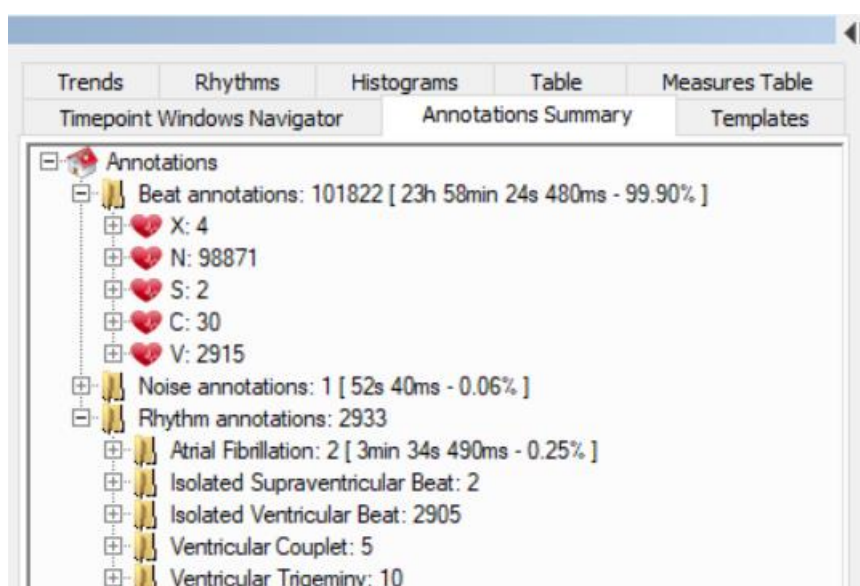
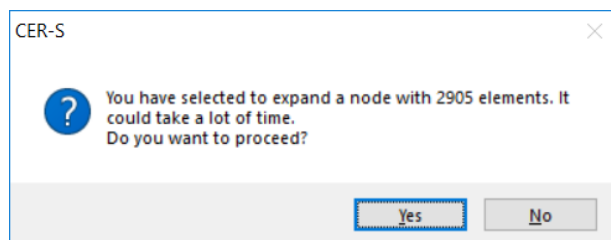


Figure 49 – Annotations Summary – Summary of ECG Beat labels, Noise and Rhythm Annotations for a continuous recording

In case a node with more than 1'000 beats is selected, a warning message is prompted informing the user that expanding such node could take some time.

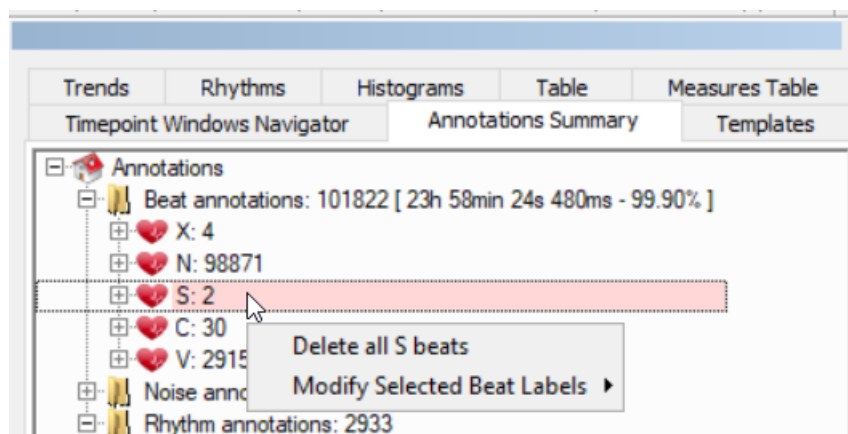


The element-listings are interactive. By clicking on a given element, the *Continuous ECG Viewer* or *Rhythm & Beat Editor* is synchronized to display the first of the selected ECG beats, then with the navigation toolbar buttons (refer to section 3.4.9 for more details) or the related shortcut key, it is possible to display the other selected beats.



Figure 50 – Annotations Summary module synchronized with the Rhythm & Beat Editor: a beat selected on the Annotations Summary module is shown on the right

Depending on the version of CER-S in use, *Rhythm & Beat Editor* may be available. In this scenario, editing is possible. By clicking the secondary mouse button on an ECG type node, a context menu is displayed allowing the deletion of all beats of the selected type or the relabeling of all the selected beats.



In addition to the ECG beats, if Rhythm Annotation has been computed or loaded, these are also reported on the Annotations Summary in the lower part.

3.10.2. Noise & Rhythm Annotation Details

The list of Noise Regions and Rhythm Annotations is given here. By selecting an item on the Annotations Summary, the selected annotation can be displayed on the *Continuous ECG Viewer* or *Rhythm & Beat Editor Viewer*, then with the navigation toolbar buttons (refer to section 3.4.9 for more details) or the related short cut key, it is possible to display the other selected items.



Figure 51 – Annotations Summary module synchronized with the Rhythm & Beat Editor Viewer: a "Bradycardia" rhythm annotation is selected on the Annotations Summary and it is shown on the right

In case there are one or more Noise Regions, the number of regions with the overall length and the percentage against the recording length are reported.

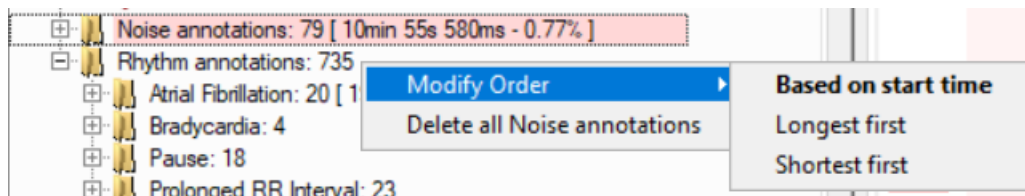
Noise annotations: 6 [2min 29s 564ms - 0.18%]

When the node is maximized, each single Noise Region is reported with its length and the date/time stamp.

* 19-Dec-2001 07:43:58.638 [55s 677ms]

By clicking the secondary mouse button on the main Noise Annotations node, the following context menu is displayed allowing:

- deletion of all Noise regions (only if *Rhythm & Beat Editor* is available and thus editing is allowed).
- modification of Noise regions order
 - Based on start-time
 - Based on length, longest first
 - Based on length, shortest first



The Annotations Summary, Below the noise information, Rhythm Annotations (with the overall number) are listed, grouped on Rhythm Annotation type. For the majority of Rhythm Annotations, the reported details are the date/time stamp and the duration, as for the Prolonged RR intervals here show.

19-Dec-2001 08:17:09.872 [3s 355ms]

For "Bradycardia", "Ventricular Tachycardia" and "Supraventricular Tachycardia" Rhythm Annotations, the following details are reported:

- # of beats
- shortest RR
- longest RR
- average RR

While, for "Ventricular Run" and "Supraventricular Run", the following details are reported:

- # of beats
- shortest RR
- longest RR
- average RR
- first RR (N-V or N-S)
- HR Max

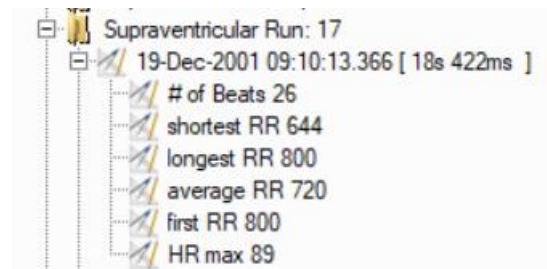


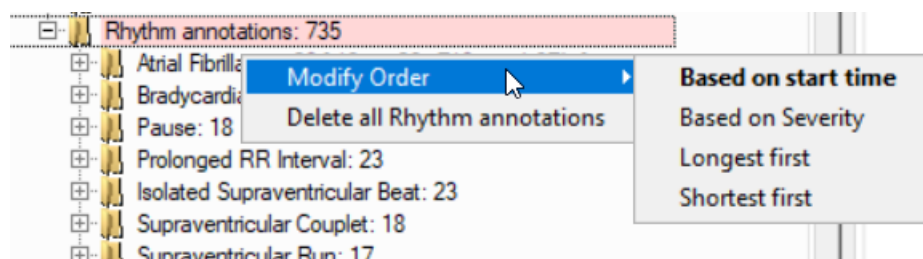
Figure 52 – Annotations Summary module reporting the details for a Supraventricular Run Rhythm annotation

As for Noise regions, by clicking the secondary mouse button on the main Rhythm Annotations node, a context menu is displayed allowing:

- the deletion of all Rhythm Annotations (if *Rhythm & Beat Editor* is available and thus editing is allowed).
- the modification of Noise regions order
 - Based on start-time
 - Based on severity
 - Based on length, longest first
 - Based on length, shortest first

The severity of a rhythm annotation change in according to its type:

- Isolated V/S: RR value - shortest is the most severe
- S/V couplet: duration - shortest is the most severe
- S/V Run: # of beats - longest is the most severe
- Sup./Vent. Tachycardia: mean RR - lowest (fastest Tachycardia) is the most severe
- Bradycardia: mean RR - longest (slowest Bradycardia) is the most severe
- Prol. RR, Pause, S/V Bigeminy and Trigeminy, AFib: duration - longest is the most severe



By clicking the secondary mouse button on a Rhythm Annotation node of a given type, a context menu is displayed allowing the deletion of all Rhythm Annotations of the selected type.

When an annotation type node is maximized, it is possible to display any annotation by clicking directly on the node. It is possible to select more than one annotation node, clicking the mouse button with the CTRL keyboard key pressed.

Similarly, it is possible to make a contiguous selection of annotations, by clicking on the first item and on the last, keeping the SHIFT keyboard key pressed.

By clicking the secondary mouse button on the selection is then possible to delete all the selected items.

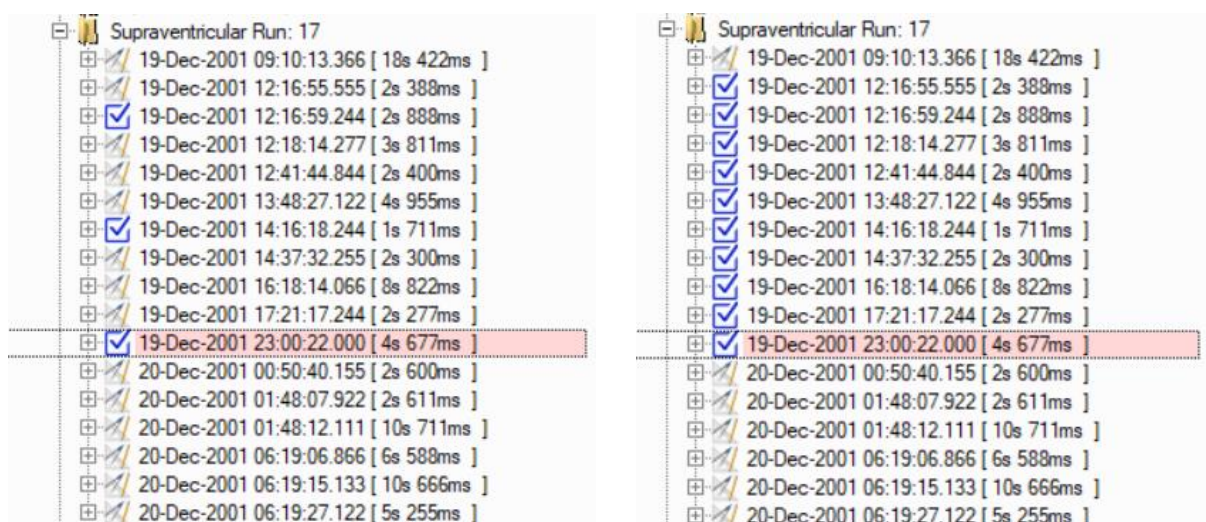


Figure 53 – Event selection with the use of CTRL (on the left) and SHIFT keyboard keys (on the left)

It is possible to customize the action performed when deleting rhythm annotations.

By default, a noise region is added replacing the deleted annotation and this configuration shall be the preferred one.

Differently it is possible to remove the event and automatically relabel the underlying ECG beats. This feature only occurs on VT and SVT Isolated/Couplets/Run and Tachycardia events.

Last it is possible to delete the event without any additional action.

This selection can be done in the upper section of the Data Editing Options dialog, displayed by selecting Editing Settings entry from the Options menu, see Figure 54.

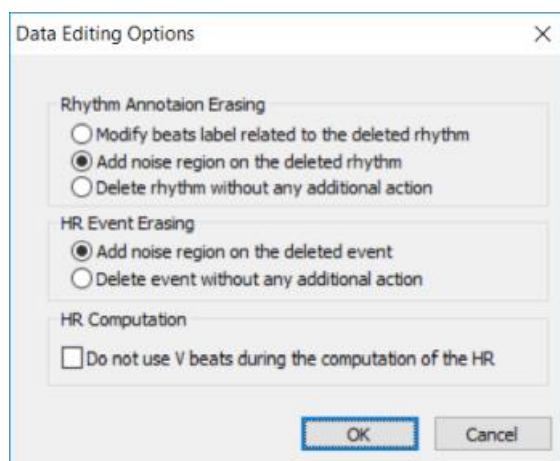


Figure 54 – Data Editing Options allowing the selection of the action to be performed when deleting rhythm annotations or HR events.

3.10.1. HR and HR Events

In CER-S software, Heart-Rate is computed for all ECG beats using a 10s window prior the ECG beat location and can be computed in two different ways:

- using all available beats
- excluding V beats

The HR computation strategy can be configured in the lower section of the Data Editing Options dialog, displayed by selecting Editing Settings entry from the Options menu, see Figure 54.

In the node HR Events are reported special heart rate related events, namely minimum and maximum RR and heart rate.

These events are automatically computed when loading a recording or when editing is performed.

The interaction with these nodes allows for a quick identification of namely minimum and maximum RR and heart rate throughout the recording.

Similarly to standard Rhythm annotations, also for HR events it is possible to customize the action performed when deleting an event.

By default, a noise region is added replacing the deleted annotation and this configuration is to be generally used.



Differently it is possible to delete the event without any addition of noise. In case this latter option is selected, HR events review shall be performed at the very end of the analysis process, otherwise, in case of beat or rhythm annotation editing is performed after HR events editing, inconsistencies between Table and Annotation Summary may be present.

This selection can be done in the lower section of the Data Editing Options dialog, displayed by selecting Editing Settings entry from the Options menu, see Figure 54.

3.11. Trends Display

This advanced interactive display allows ECG beat information to be visualized as "RR vs Time" or "Poincaré" display (RR vs RR + x), in a X/Y dot-plot, where each dot represents an ECG beat. Beats labeled as C or X are not shown in this graph.

This display is not available in case of Multiday recordings.

It is possible to select one or more beats and review them in the *Rhythm & Beat Editor* or in case this is missing, in the *Continuous ECG Viewer*. The selection can be performed with a rectangular shape (selecting the  icon) or freehand () drawn, as shown here below.

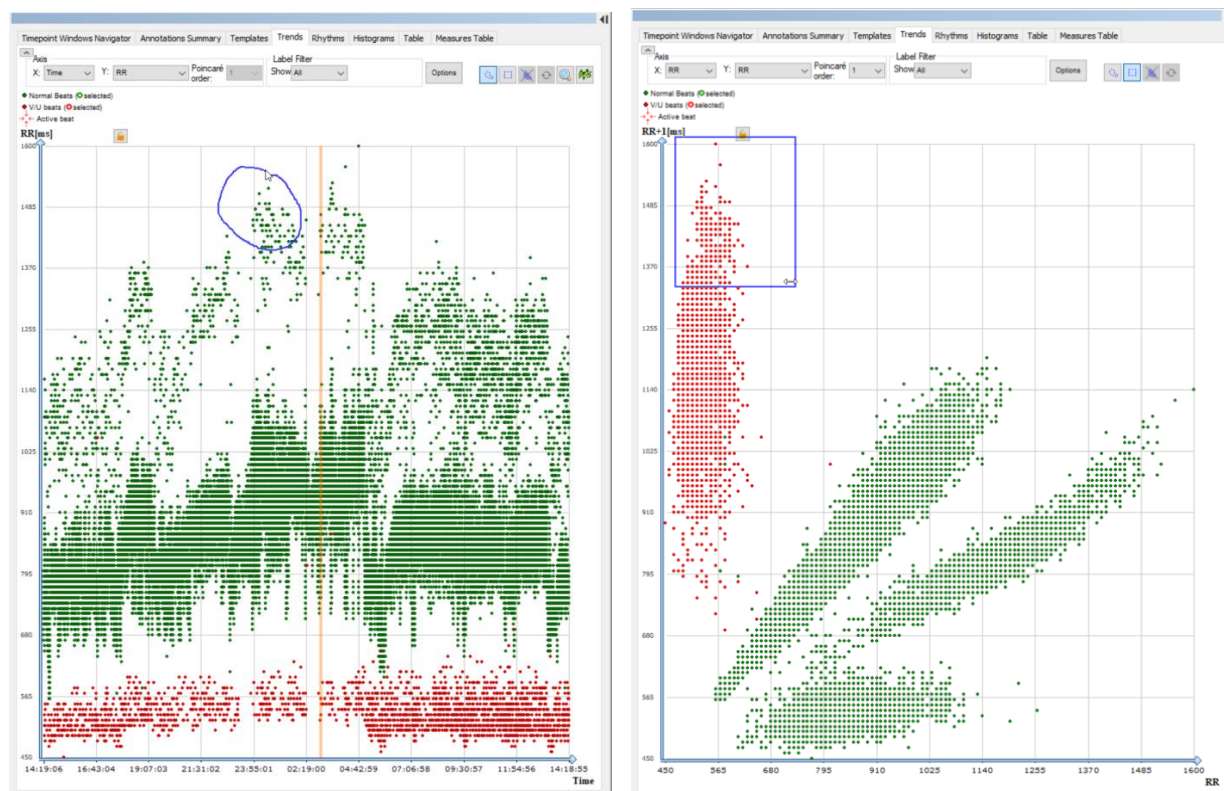


Figure 55 – Selection of ECG beats in the Trends display, with Freehand (left) and Rectangular selection (right)

The trend display is interactive: selecting one or multiple dots, the Continuous ECG Viewer or the Rhythm & Beat Editor Viewer is updated to show the first beat of the selection (Figure 56).

In *Continuous ECG Viewer* or *Rhythm & Beat Editor*, it is possible to navigate through the selected ECG beats using the navigation button as described in section 3.4.9.

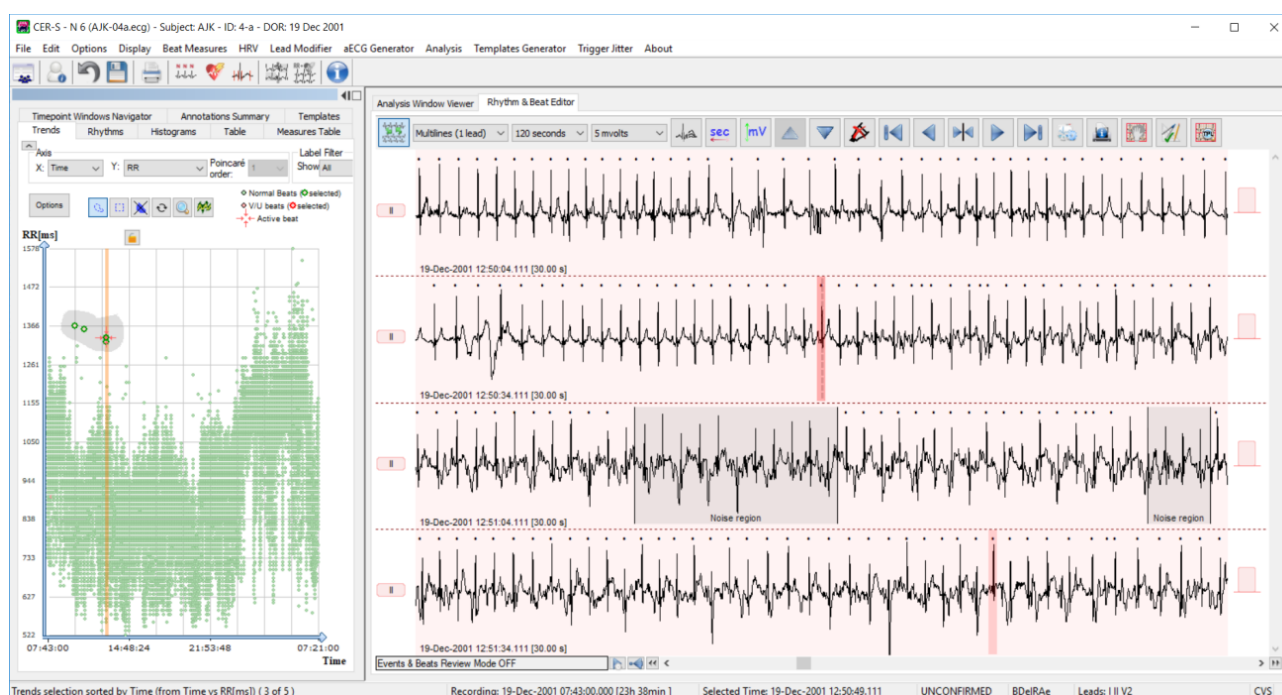










Figure 56 – Selection of ECG beats in the Trends display synchronized with the Beat Editor Viewer

Clicking the  icon, it is possible to reset the current selection by clicking the  button from *Continuous ECG Viewer* or *Rhythm & Beat Editor* toolbar.

Clicking the  icon, it is possible to invert the current selection (select the unselected beats).

Clicking the  /  buttons, it is possible to hide/show all the Trends buttons and settings, and thus maximize the size of the graphs.

In case of time trends (where time is selected on the X axis), two additional buttons are available to:

- Display/hide the mean RR/HR trends, with the button 
 - o If the mean RR/HR is displayed, it is possible to hide/show the ECG beat-dots from the graph, with the button 
- Zoom the tachogram (time RR display) with the button , enabling/disabling the time-scrolling of the displayed trend. Here the entire trend is displayed on the lower portion, while on the upper one, the zoomed trends is displayed.

It is possible to scroll in time with the horizontal scrollbar, with the yellow arrows or by clicking and dragging the grayed area of the lower display.

Scrolling options are described in the 'advanced' section of the Options dialog box, refer to section 3.11.2.

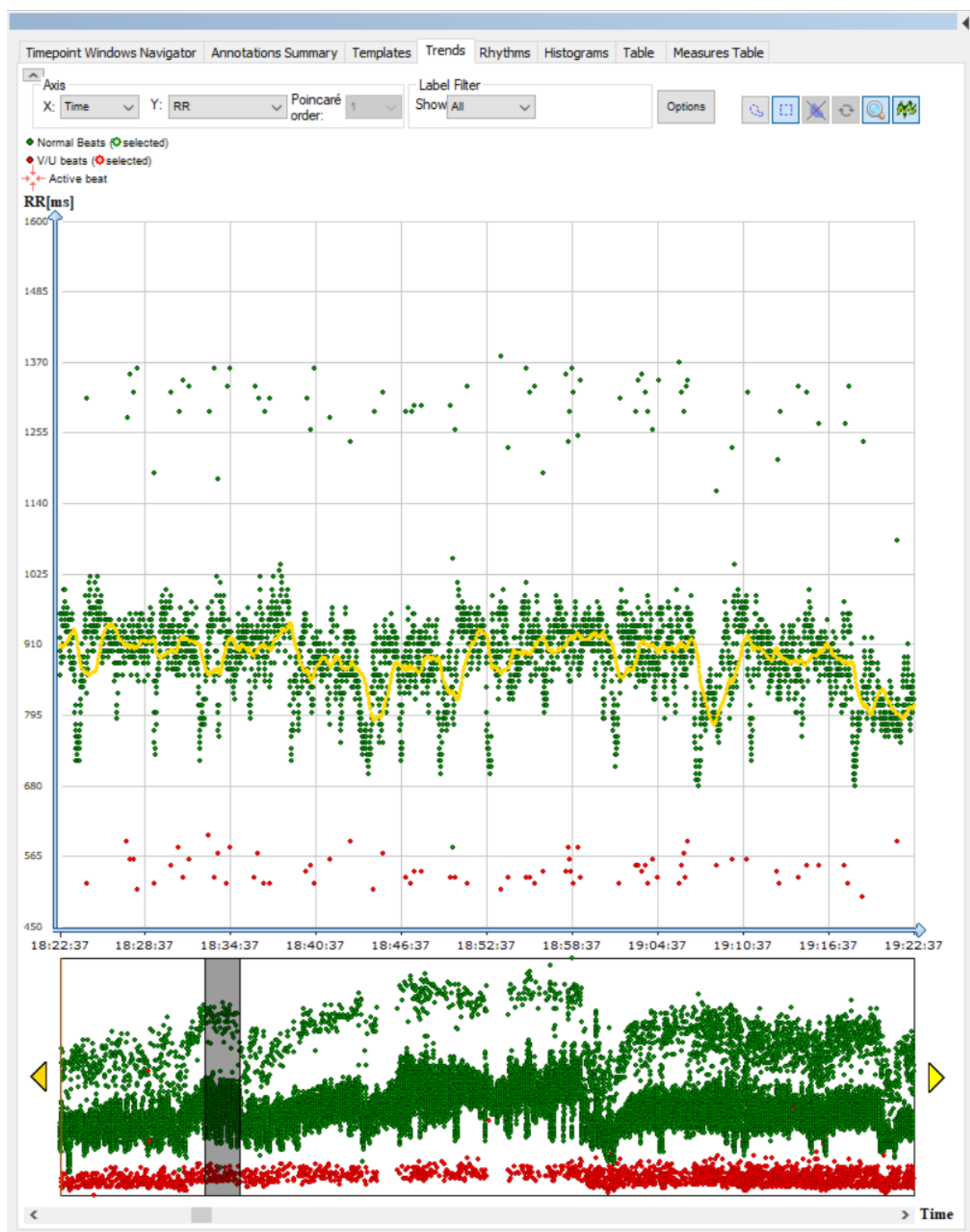
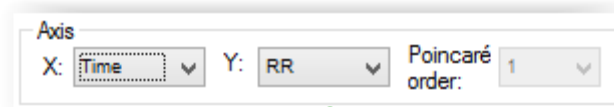


Figure 57 – Trends display with Zoom feature active with zoomed resolution of the upper display set to 60 minutes

In the "Axis" section, it's possible to configure the ECG beat information to display.



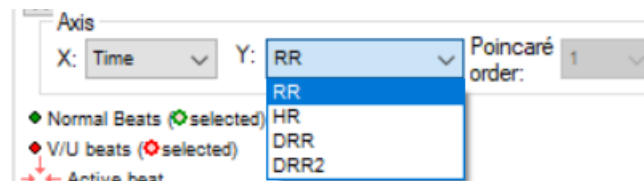
The leftmost drop-down menu allows to set the parameters on the X axis. Two entries are available:

1. *Time*, to display "RR vs Time" information
2. *RR*, to display "Poincaré" plot; refer to section 3.11.1.

The second drop-down menu allows the parameter of the Y axis to be set. The available entries depend on the previous X axis selection.

In case of Time trend, the available options are:

- RR: to plot the RR value on the x-axis versus the previous RR value on the y-axis
- HR: heart rate
- DRR: ratio between the current RR value and the previous RR value
- DRR2: ratio between the current RR value and the value before the previous RR value



The "Poincaré order" drop-down menu is enabled only if the RR entry of the X Axis section has been selected; refer to section 3.11.1.

In the "Label filter" section on the top of the diagram (see Figure 58), it is possible to filter the dots to be displayed. The possible entries are:

- All: all beats are displayed
- N-N: only 'N' beats followed by an 'N' beat are displayed
- V-V: only 'V' beats followed by a 'V' beat are displayed
- S-S: only 'S' beats followed by an 'S' beat are displayed
- N-V: only 'N' beats followed by a 'V' beat are displayed
- V-N: only 'V' beats followed by an 'N' beat are displayed
- N-S: only 'N' beats followed by an 'S' beat are displayed
- S-N: only 'S' beats followed by an 'N' beat are displayed
- N-U: only 'N' beats followed by an 'U' beat are displayed
- U-N: only 'U' beats followed by an 'N' beat are displayed
- N-B: only 'N' beats followed by an 'S' beat are displayed
- B-N: only 'S' beats followed by an 'N' beat are displayed
- *-N: only beats followed by an 'N' beat are displayed
- N-*: only 'N' beats are displayed
- *-V: only the beats followed by a 'V' beat are displayed
- V-*: only 'V' beats are displayed
- *-S: only beats followed by an 'S' beat are displayed
- S-*: only 'S' beats are displayed
- *-B: only beats followed by a 'B' beat are displayed
- B-*: only 'B' beats are displayed

- *-U: only beats followed by a 'U' beat are displayed
- U-*: only 'U' beats are displayed
- Not V: all Normal beats are displayed (except 'V' beats)

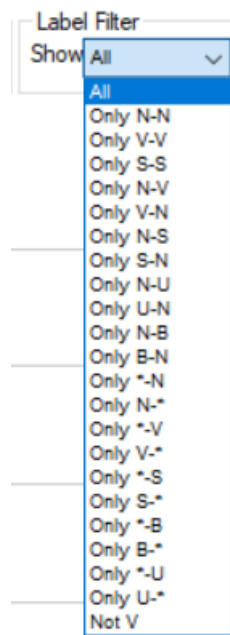


Figure 58 – "Label Filter" combo-box menu in the Trends tab

In case one of the label filtering options from the second to the twelfth is selected, it is then possible to select which RR intervals shall be displayed.



For example, in case N-V label filter option is selected, by selecting the N check-box, the display of all normal beats followed by a Ventricular beat is enforced; on the other hand by selecting the V check-box, the display of all Ventricular beats preceded by a normal beat is enforced.

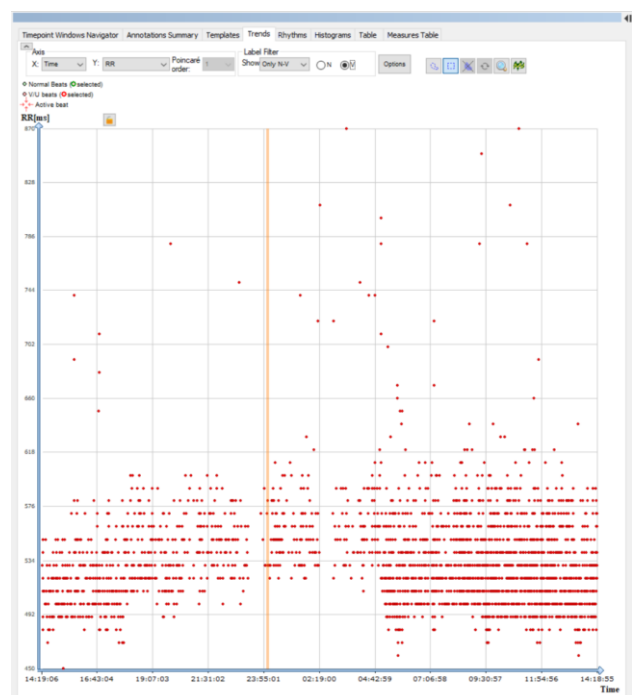
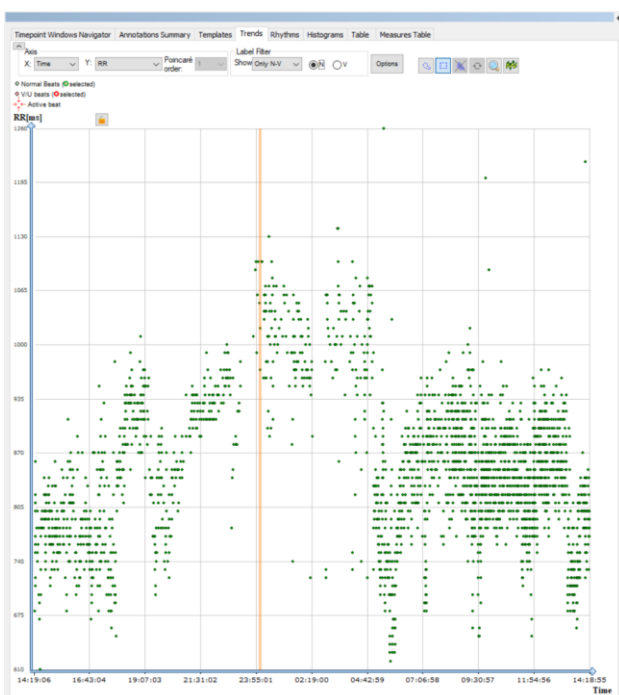


Figure 59 – Trends display with N-V label filtering option. On the left where the "V" check-box is selected, V beats preceded by N beats are displayed; on the right where the "N" check-box is selected, N beats followed by V beats are displayed

Clicking the secondary mouse-button on the selected region, if *Rhythm & Beat Editor* is available and thus editing is allowed, the following context menu is displayed (Figure 60). Under this menu, it is possible to:

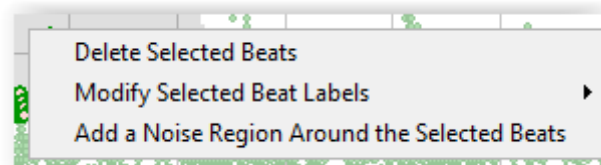


Figure 60 – Context Menu for a selection of dots in the Trends view

- delete selected beats
- modify selected beat label. The list of available beat categories is:
 - N – Normal Beat
 - V – Ventricular Beat
 - S – Supraventricular Beat
 - C – Calibration Pulse
 - B – Beat with Bundle Branch Block
 - P – Paced Beat
 - E – Ventricular Escape Beat
 - F – Fusion Beat
 - U – Unknown Beat
 - X – Artifact
- Add a noise region around the selected beats

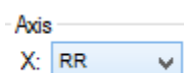
The dots are colored according with the beat label: the default color is green for the Normal (all but ventricular and unknown) beats and red for ventricular (V) and unknown (U) beats. The selected dots are colored in a different way, only the border keeps the original color.

Clicking the secondary mouse-button out of the selected region, and the Trend is time-based. The start time of the displayed ECG in the *Continuous ECG Viewer/Rhythm and Beat Editor* is modified according to the selected point and the current start time is displayed in the Time-Trends by a vertical bar.

3.11.1. “Poincaré” Plot

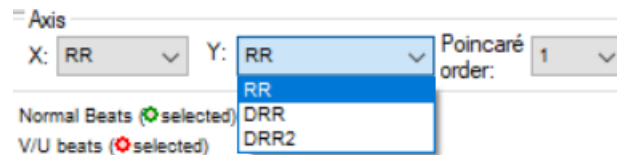
Poincaré plots are return maps in which each result of measurement is plotted as a function of a previous one.

Selecting the RR entry in the 'X' axis drop-down menu, it is possible to visualize the ECG beat information as “Poincaré” display.

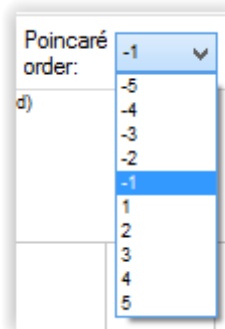


The second drop-down menu allows the parameter of the Y axis to be set. The available entries are:

- RR: to plot the current RR value on the x-axis versus the previous RR value on the y-axis
- DRR: ratio between the current RR value and the previous RR value
- DRR2: ratio between the current RR value and the value before the previous RR value



The “Poincaré order” drop-down menu allows the user to choose the order when true Pincaré plot (RR vs RR) is selected. The available entries are: -5, -4, -3, -2, -1, 1, 2, 3, 4, 5.



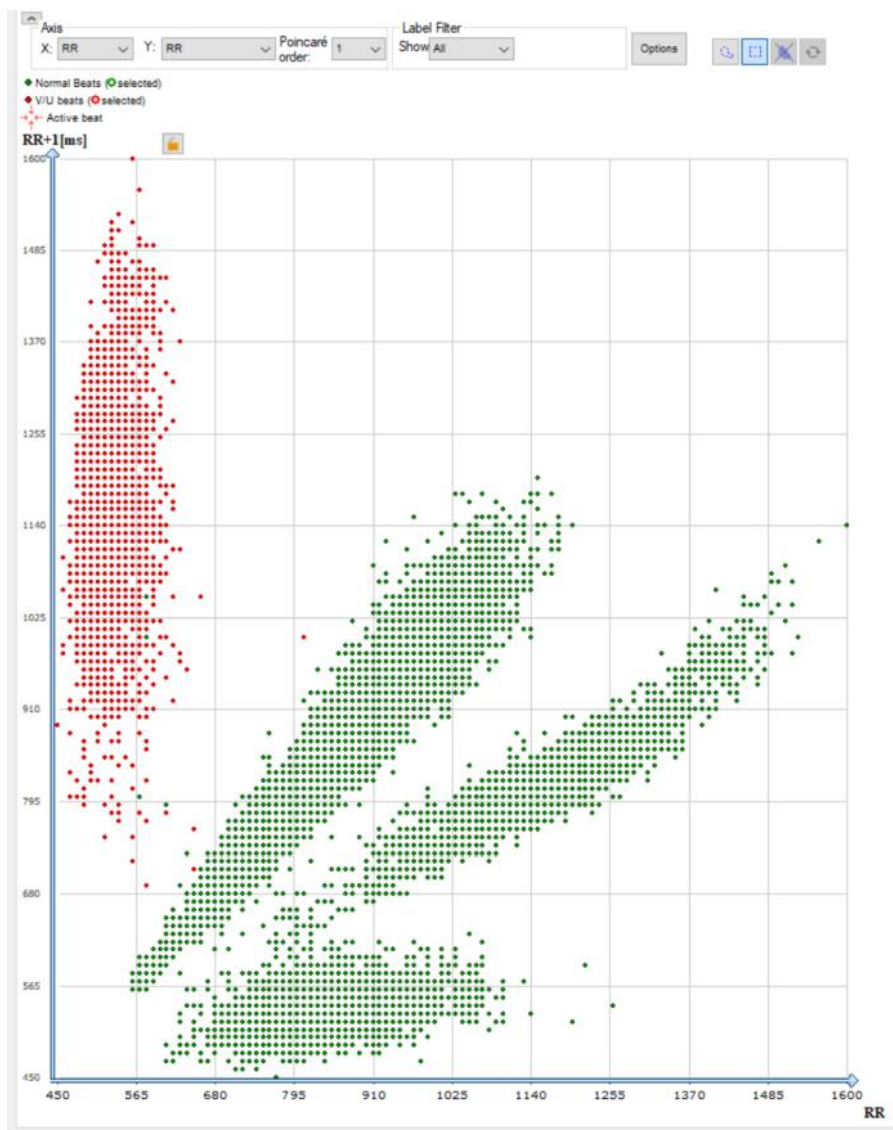


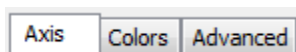
Figure 61 – Example of Poincaré plot (RR vs RR-1)

3.11.2. Trends Option

The Trends Options dialog is invoked by clicking the  button next to the Axis section.

This dialog is divided in three tabs, as described below:

- Axis
- Colors
- Advanced



- Axis (for Time Trends)

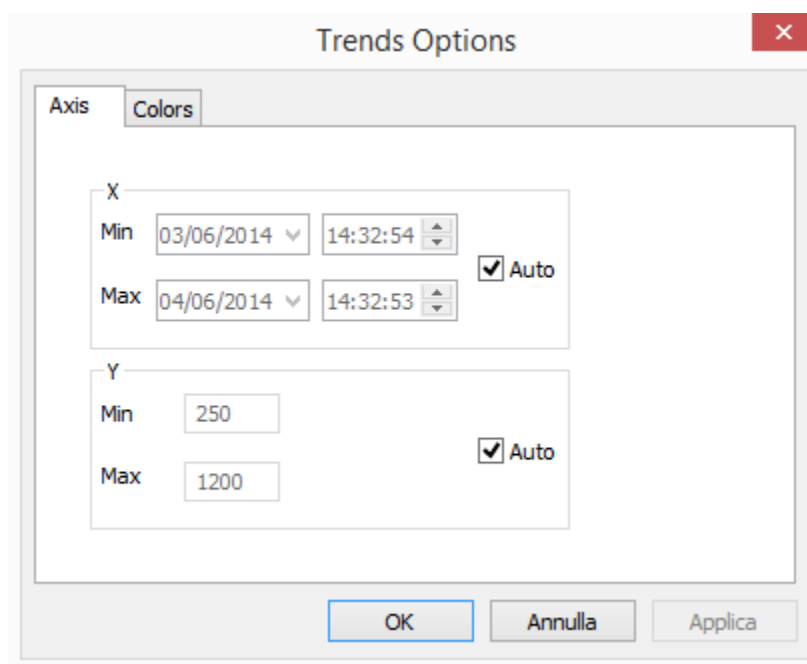


Figure 62 – Trends Option Dialog for Time-Trends plot, Axis tab

In this tab, the user can set the maximum and minimum time-values to display on X-axis and the maximum and minimum values for Y-axis. Selecting “Auto”, the graph is updated to show all beats according to the Label Filter choice.

- Axis (Poincaré Plot)

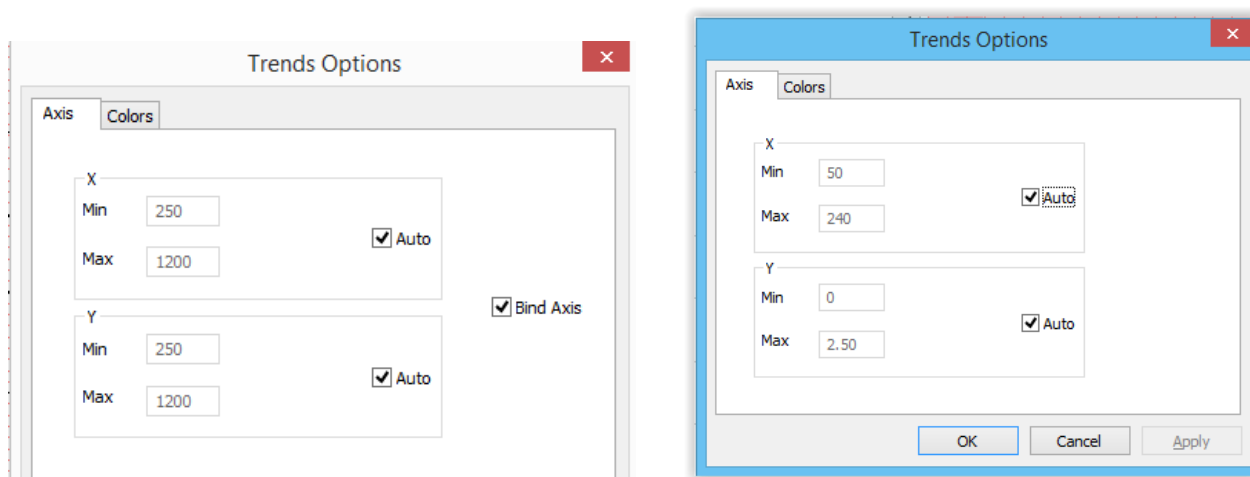


Figure 63 – Trends Option Dialog for Poincaré-like plot, Axis tab. In the first screenshot, the dialog is shown on a true Poincaré where both axes is RR interval (and it is possible to bind the two axis). In the second screenshot, the dialog is shown on a Poincaré-like where only one axis is RR interval

In this tab, the user can set the maximum and minimum values to display for each axis. Selecting “Auto”, the graph is updated to show all the beats, according to the Label Filter choice.

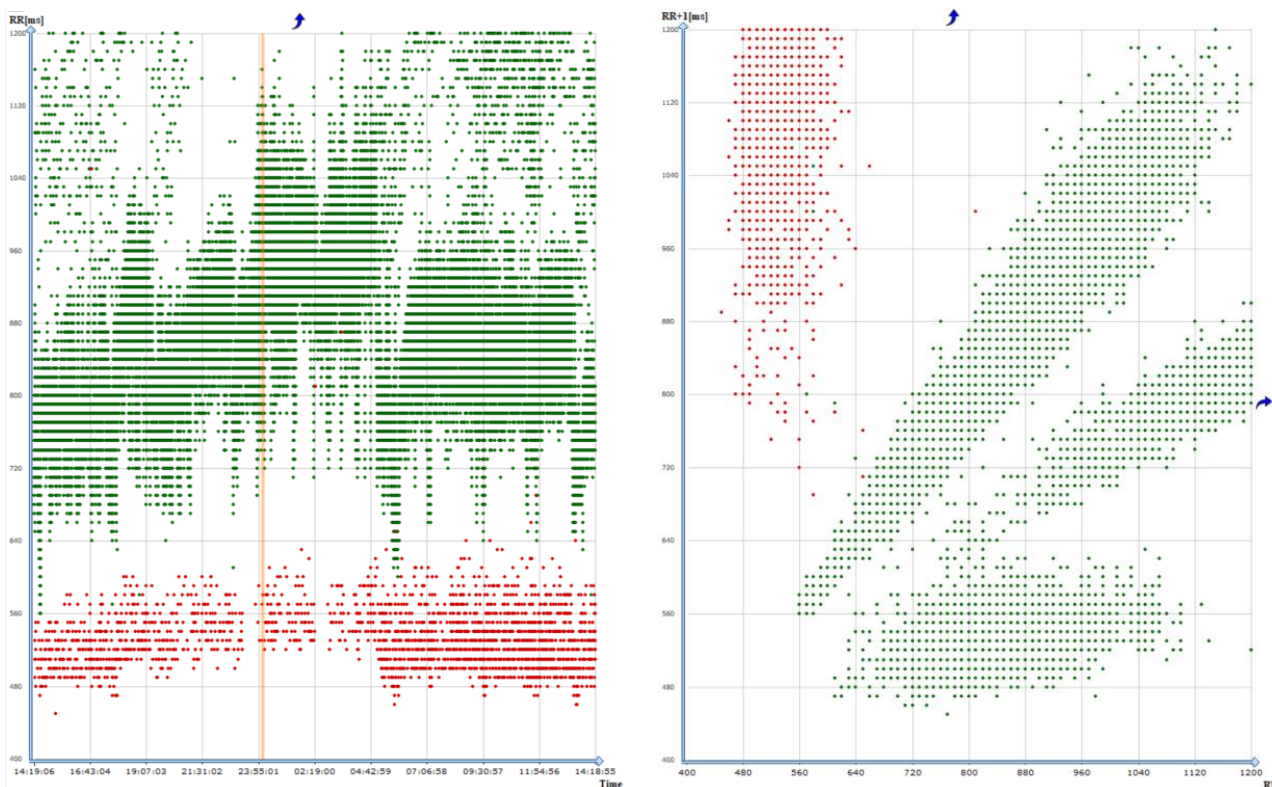


Figure 64 – Time-Trends and Poincaré plots fixed scale, with the top/left arrows it is possible expand the graph to include all ECG beat-dots

- Color

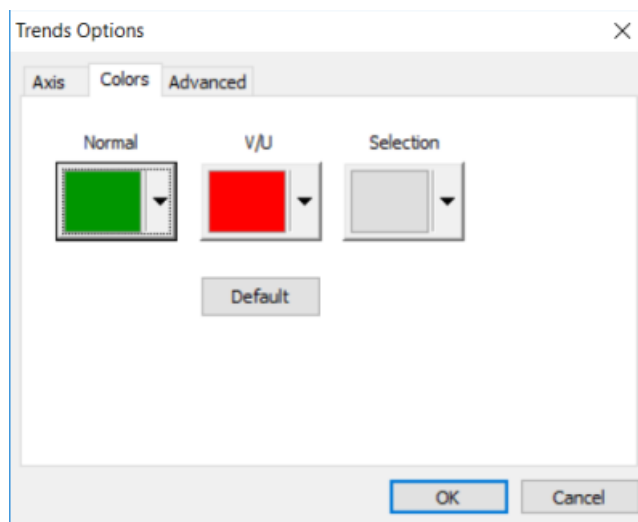


Figure 65 – Trend Option Dialog, Color tab

In this tab, the user can choose the color of the dots representing the Normal beats, the V beat and the color of the selection area.

- Advanced

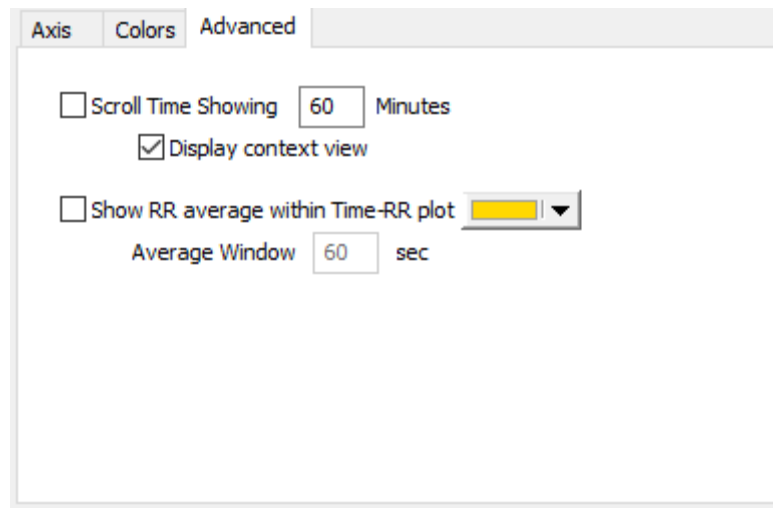


Figure 66 – Trend Option Dialog, Advanced tab

In this tab, the user can choose to show or not to show the average RR/HR and its color superimposed on the trend. The color of the average as well as the dimension of the time-window used to compute it can be modified.

It is also possible to reduce the displayed time to a given window (default: 60 minutes), if this option is checked, it is possible to scroll the time.

If the time-scrolling is active, it is possible to display a context view of the whole trend above the 'reduced' one, as shown in Figure 57.

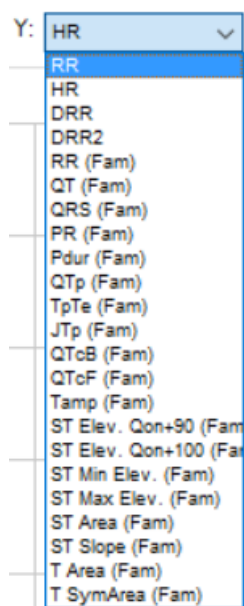
In the context view, the portion displaying time is highlighted with a grey window and it is possible to scroll the trend using that window, which can be reduced and enlarged using the mouse, changing the displayed time.

The options in the "Advanced" tab takes effect only when the displayed trend is time based.

3.11.3. Families Trends

In case the "Beat measures analysis" (3.21) has been performed, it is possible to review the computed measures, changing the parameter of the Y axis. The available measurements are:

- RR(Fam), RR of the representative beat of the family
- QT, QRS, PR, Pdur, QTp, TpTe, JTp, QTcB, QTcF, Tamp
- ST Elevations (in according to the analysis options, ref. sec. 3.21.1 for details)
- ST Area (only in case of multiple elevations points)
- ST Slope (only in case of multiple elevations points)
- T Area
- T Symmetry



The measures are displayed with grey dots to distinguish them from the beats (see Figure 68).

Once a measure is selected on the Y axis, the 'label filter' menu (Figure 58) is hidden and substituted by the 'lead' and 'period' menu.

Since the analysis can be performed on several leads (in addition to the VM) and on several periods (ref. to 3.21.1), it is possible to change the current lead and period.



The 'period' menu is available only in case a multiple-period analysis has been performed.

For the beats it is possible to select one or more families and review them in the "adjust measures dialog box" (ref. to 3.21.3 for details).

It is also possible to select all the displayed families and review them by double-clicking on the trends. The families' navigation in the 'adjust measures dialog' starts from the family adjacent to the mouse-click position (for example, see Figure 67).

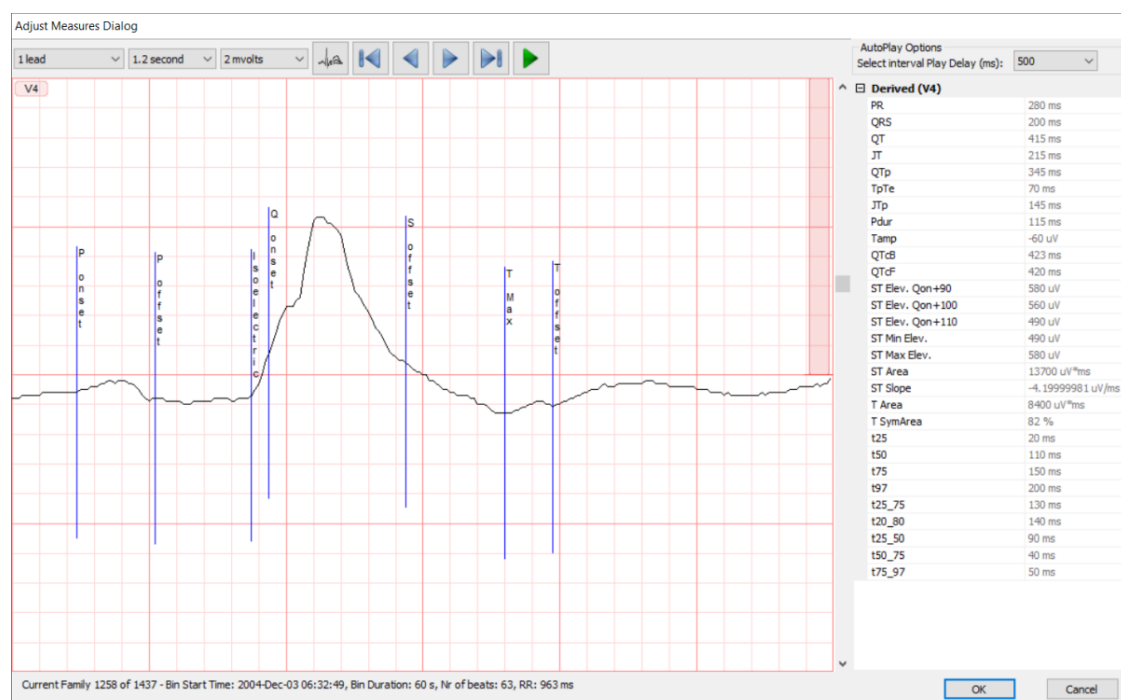


Figure 67 – Adjust measures dialog: all families selected. The families' navigation starts at the 1258th family selected by double-clicking on trends

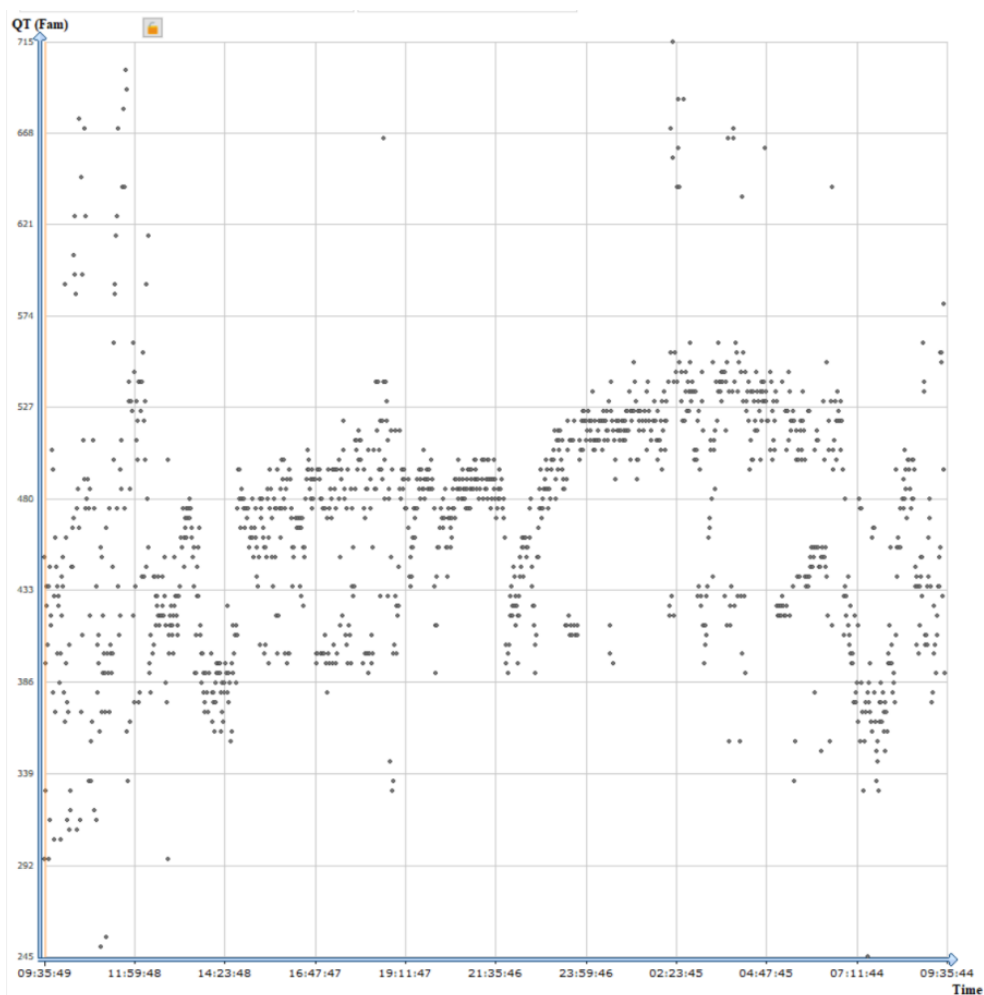


Figure 68 – Family-Trends plot: the grey dots represent the selected measures of the computed families

3.12. Table Display

Under the Table tab, ECG and Rhythm summary information is reported in a tabular format (see Figure 69).

In the table, the following can be reported for each time bin (the default value is one hour), for day/night periods and for the entire record:

- Analysed time, in percentage against the time interval length;
- Beat-related values (RR/HR min, max, mean and standard deviation) and up to 9 beat-label-related value highlighted in red: N (normal sinus rhythm), PVC (ventricular), S (supraventricular), Pace (paced), Calib (calibration pulse), Fusion, Unknown, Vesc (ventricular escape), BBB (bundle branch block)
- Up to 21 Rhythm related values, highlighted in green:
 - Brady (bradycardia)
 - Pauses
 - Prolonged RR Interval
 - SV Tachy (supraventricular tachycardia)
 - SVPB Isolated (isolated supraventricular beat)
 - SV Couplet (supraventricular couplet)
 - SV Run (supraventricular run)
 - SV Bg (supraventricular bigeminy)
 - SV Tg (supraventricular trigeminy)
 - ATachy (atrial tachycardia)
 - AFib (atrial fibrillation)
 - AFlutter (atrial flutter)
 - V Tachy (ventricular tachycardia)
 - VFib (ventricular fibrillation)
 - VFlutter (ventricular flutter)
 - Torsade de Pointes
 - V Isolated (isolated ventricular Beat)
 - V Couplet (ventricular couplet)
 - V Run (ventricular run)
 - V Bg (ventricular bigeminy)
 - V Tg (ventricular trigeminy)
- Atrioventricular Block annotations:
 - First-degree AVB
 - Type 1 Second-degree AVB
 - Type 2 Second-degree AVB
 - Third-degree AVB
- All measure-related min/max/mean values (in case the Beat Measure Analysis has been performed), highlighted in blue, related to the lead selected in the drop down menu
 - QT
 - QRS
 - PR
 - P dur (P-wave duration)

- QTp (interval between QRS onset and T-wave peak)
- TpTe (interval between T-wave peak and T-wave offset)
- JTp (interval between QRS offset (J point) and T-wave peak)
- QTcB (QT interval correct with Bazett's formula)
- QTcF (QT interval correct with Fredericia's formula)
- T amp (T-wave amplitude)
- ST Ele (ST displacement)
- ST Area (area of ST segment from the first to the last elevation point analysed; only available if more than one elevation point is analysed)
- ST slope (only available if more than one elevation point is analysed and it will be the linear interpolation of ST displacement at the various points)
- T Area (T-wave area; computed from T-wave onset and T-wave offset)

Options		Export		V1	Beat related Rhythm related Measure related								
Time	Analyzed	n	V Bg	V Tg	N Beats	V Beats	S Beats	QT max	QT min	QT Ave...	QRS max	QRS min	QRS Av...
09:35:49 - 09:59:59	99.9%	-	-	-	1758	19	7	485	380	409.17	225	85	154.79
10:00:00 - 10:59:59	100%	-	-	-	3884	13	6	440	375	423.33	165	75	153.42
11:00:00 - 11:59:59	99.7%	-	-	-	3983	74	8	465	330	419.17	200	80	150.08
12:00:00 - 12:59:59	100%	-	-	-	3943	5	1	460	395	433.50	170	140	159.17
13:00:00 - 13:59:59	100%	-	-	-	4537	5	-	455	345	413.08	180	140	157.08
14:00:00 - 14:59:59	100%	-	-	-	5185	5	1	465	340	388.75	185	70	157.50
15:00:00 - 15:59:59	100%	-	-	-	3694	-	-	460	430	445.67	170	140	159
16:00:00 - 16:59:59	100%	-	-	-	3838	2	1	480	405	439.67	170	130	156.83
17:00:00 - 17:59:59	100%	-	-	-	3616	1	2	485	415	451.83	170	135	158.17
18:00:00 - 18:59:59	100%	-	-	-	3406	-	5	475	420	454.17	170	135	156.67
19:00:00 - 19:59:59	100%	-	-	-	3968	-	1	470	415	448.67	165	135	156.50
20:00:00 - 20:59:59	100%	-	-	-	3984	-	-	465	370	445.08	180	135	153.83
21:00:00 - 21:59:59	100%	-	-	-	3817	1	2	470	375	446	170	135	155.92
22:00:00 - 22:59:59	100%	-	-	-	4122	4	2	455	370	429	170	85	157.33
23:00:00 - 23:59:59	100%	-	-	-	3410	2	8	480	430	459	170	85	154.00
00:00:00 - 00:59:59	100%	-	-	-	3324	-	8	475	450	463	170	85	164.75
01:00:00 - 01:59:59	100%	-	-	-	3112	1	6	480	460	471.75	170	145	164.00
02:00:00 - 02:59:59	100%	-	-	-	3230	1	6	480	460	471.42	170	95	160.50
03:00:00 - 03:59:59	100%	-	-	-	3406	4	6	480	415	464.67	170	75	151.92
04:00:00 - 04:59:59	99.8%	-	-	-	3283	-	12	480	445	467.83	170	140	158.92
05:00:00 - 05:59:59	100%	-	-	-	3185	1	11	485	445	468.67	170	135	150.00
06:00:00 - 06:59:59	100%	-	-	-	3374	-	7	495	405	459.83	170	75	153.58
07:00:00 - 07:59:59	100%	-	-	-	5185	12	3	415	345	376.33	185	140	153.92
08:00:00 - 08:59:59	100%	-	-	-	4294	4	1	460	355	419.75	170	145	156.95
09:00:00 - 09:35:44	92.2%	-	-	-	2390	3	7	440	370	410.78	165	75	155.31
All Days: 08:00:00 - 20:...	99.6%	-	-	-	48496	131	40	485	330	430.33	225	70	156.18
All Nights: 23:00:00 - 0...	100.0%	-	-	-	22950	9	57	495	405	465.77	170	75	157.21
Entire Recording	99.8%	-	-	-	91928	157	111	495	330	440.53	225	70	156.47

Figure 69 – Table tab display

The two buttons on the top left allow to access table configuration option (refer to section 3.12.2) and to export the table in CSV format.

The drop-down menu, only available in case Beat Measure Analysis has been performed, allow to select the lead to which the annotations are related.

The table display is interactive: upon clicking the primary mouse-button on HR and RR min/max event or to rhythm annotation events or to beat label on the table, the *Continuous ECG Viewer* or the *Rhythm & Beat Editor* gets updated to show the selected item.

In *Continuous ECG Viewer* or *Rhythm & Beat Editor*, it is then possible to navigate through the selected items using the navigation buttons described in section 3.4.9.

By clicking the primary mouse-button on beat measurement min/max values, the Adjust Measure dialog will be loaded to allow manual adjustment of ECG annotations, refer to section 3.21.3 for more details.



Figure 70 – Table display: selection of the "RR min" value in the fourth time-interval (12:00:00 - 12:59:59) of the recording synchronized with the Rhythm & Beat Editor

3.12.1. Table in Multiday analysis

In the Table tab, multiday Rhythm summary information is reported in a tabular format (see Figure 71).

The following information are reported for each time bin of a fixed length of 24 hours and for day/night periods for each day and for the entire record:

- Analysed time, in percentage against the time interval length;
- Beat-related values for RR and HR (min, max, mean and standard deviation)
- 8 Rhythm related values, highlighted in green:
 - Pauses
 - ATachy (atrial tachycardia)
 - AFib (atrial fibrillation)
 - AFlutter (atrial flutter)
 - V Tachy (ventricular tachycardia)
 - VFib (ventricular fibrillation)
 - VFlutter (ventricular flutter)
 - Torsade de Pointes
- Atrioventricular Block annotations

Timepoint Windows Navigator Annotations Summary Templates Trends Rhythms Histograms Table Measures Table									
Options		Export		Beat related		Rhythm related			
Time	Analyzed	RR Max	RR Ave...	RR StDev	HR Min	HR Max	HR Ave...	HR StD...	Pauses
D1 11:25:49 - 11:25:48	99.4%	2508	740	176.63	45	176	84	24.32	1(L: 2.5s)
D2 11:25:49 - 11:25:48	99.1%	7453	825	191.53	16	141	75	20.88	8(L: 9.6s)
D3 11:25:49 - 11:25:48	99.2%	2430	767	204.15	44	166	82	23.83	-
D4 11:25:49 - 11:25:48	96.9%	2625	823	196.39	43	165	76	20.32	1(L: 2.6s)
D5 11:25:49 - 11:25:48	99.6%	3273	845	223.86	40	172	75	26.56	1(L: 3.3s)
D6 11:25:49 - 11:25:48	98.1%	3469	811	181.38	42	157	76	19.82	1(L: 3.5s)
D7 11:25:49 - 11:25:49	89.1%	2570	900	201.34	40	138	69	18.49	1(L: 2.6s)
D1 Day: 08:00:00 - 20:0...	98.8%	1578	711	176.20	45	176	88	26.39	-
D2 Day: 08:00:00 - 20:0...	98.4%	7453	732	162.09	16	141	84	20.81	8(L: 9.6s)
D3 Day: 08:00:00 - 20:0...	99.6%	2430	685	173.64	44	166	91	23.38	-
D4 Day: 08:00:00 - 20:0...	97.0%	1867	743	174.64	44	165	84	19.62	-
D5 Day: 08:00:00 - 20:0...	99.2%	3273	754	200.18	43	172	85	26.03	1(L: 3.3s)
D6 Day: 08:00:00 - 20:0...	96.3%	3469	754	158.68	45	157	82	16.72	1(L: 3.5s)
D7 Day: 08:00:00 - 20:0...	78.2%	1781	785	173.01	41	138	79	17.11	-
All Days: 08:00:00 - 20:...	95.4%	7453	735	176.80	16	176	85	22.45	10(L: 9....
D1 Night: 23:00:00 - 06:...	100.0%	2508	777	163.52	48	131	79	20.07	1(L: 2.5s)
D2 Night: 23:00:00 - 06:...	99.8%	1555	974	117.51	43	98	61	12.63	-
D3 Night: 23:00:00 - 06:...	98.0%	1734	929	156.38	45	105	65	14.74	-
D4 Night: 23:00:00 - 06:...	94.6%	2625	966	147.70	43	101	62	14.77	1(L: 2.6s)
D5 Night: 23:00:00 - 06:...	100%	1844	1030	137.46	40	108	58	11.63	-
D6 Night: 23:00:00 - 06:...	99.9%	1672	897	167.46	43	109	68	14.70	-
D7 Night: 23:00:00 - 06:...	100%	2180	1033	158.17	40	100	58	12.72	-
All Nights: 23:00:00 - 0...	98.9%	2625	936	172.53	40	131	65	16.98	2(L: 2.6s)
Entire Recording	97.4%	7453	812	201.43	16	176	77	23.11	13(L: 9....

Figure 71 – Table tab display in case of multiday analysis

The two buttons on the top left allow to access table configuration option (refer to section 3.12.2) and to export the table in CSV format.

The table display is interactive: upon clicking the primary mouse-button on HR and RR min/max event or to rhythm annotation events on the table the *Continuous ECG Viewer* or the *Rhythm & Beat Editor* gets updated to show the selected item.

In *Continuous ECG Viewer* or *Rhythm & Beat Editor*, it is then possible to navigate through the selected items using the navigation buttons described in section 3.4.9.

3.12.2. Table Options


To customize the reported information, it's necessary to invoke the Table Options dialog, as shown in Figure 72, by clicking the  button or via the corresponding entry in the 'Options' menu, (see ref. 3.29.6).

Figure 72 – Table Options Dialog

In the section “Select Columns”, it is possible to set the columns to display, namely: HR and rhythm annotations

- RR interval and heart rate
 - whether the standard deviation shall be provided for RR interval and heart rate
- atrial fibrillation, atrial flutter and atrial tachycardia
- ventricular fibrillation, ventricular flutter and Torsade de Points
- bradycardia, pauses and prolonged RR
- supraventricular and ventricular arrhythmias
 - whether supraventricular and ventricular bigeminy and trigeminy shall be reported
- analyzed time
- beat labels: N (normal sinus rhythm), PVC (ventricular), S (supraventricular), Pace (paced), Calib (calibration pulse), Fusion, Unknown, Vesc (ventricular escape), BBB (bundle branch block)

In the section “Row Options”, it is possible to customize the resolution of the rows of the table:

- the Time Bins drop-down menu allows to specify the size of sub-summary intervals expressed. The allowed Time Bins entries are: 10, 15, 20, 30, 60, 90, 120, 180 minutes and 5, 12 or 24 hours; default value being 60 minutes (i.e. one hour)

- the initial time of each row (minutes:seconds); default value being "00:00". This feature allows the synchronization of the table with dosing time or to a particular event

In the section "Day/Night Options", it is possible to customize:

- The Day/Night periods and an additional optional period (T3) by entering start and end time
- The time for day change. By default it is the set tot the recording start time, but it can be modified as needed.

3.12.2.1. Table Options in Multiday analysis

In case multiday analysis was performed, most table options are fixed, as shown in Figure 73.

Figure 73 – Table Options Dialog, for Multiday recordings

- Columns are fixed and allow the display of
 - min/max/mean and std values for both RR and HR
 - Pause events
 - Atrial Tachycardia events
 - Atrial Fibrillation events
 - Atrial Flutter events
 - Ventricular Tachycardia events
 - Ventricular Fibrillation events

- Ventricular Flutter events
- Torsade de Pointes
- Atrioventricular blocks
- ECG Beats are not displayed
- Time Bins size of sub-summary intervals is set to 24 hours
- Initial time of each time bin (minutes:seconds) is set to "00:00"

In the section "Day/Night Options", it is possible to customize:

- The Day/Night periods and an additional optional period (T3) by entering start and end time
- The time for day change. By default it is the set to the recording start time, but it can be modified as needed.

3.13. Templates Display

In the Templates tab, ECG templates generated using ABILE algorithm are displayed (see Figure 74). The algorithm used for the generation of the templates is based on morphology comparison of ECG beats with same label. Beats with high morphological correlation are grouped under the same template which is classified according to the beat label.

This display is not available in case of Multiday recordings.

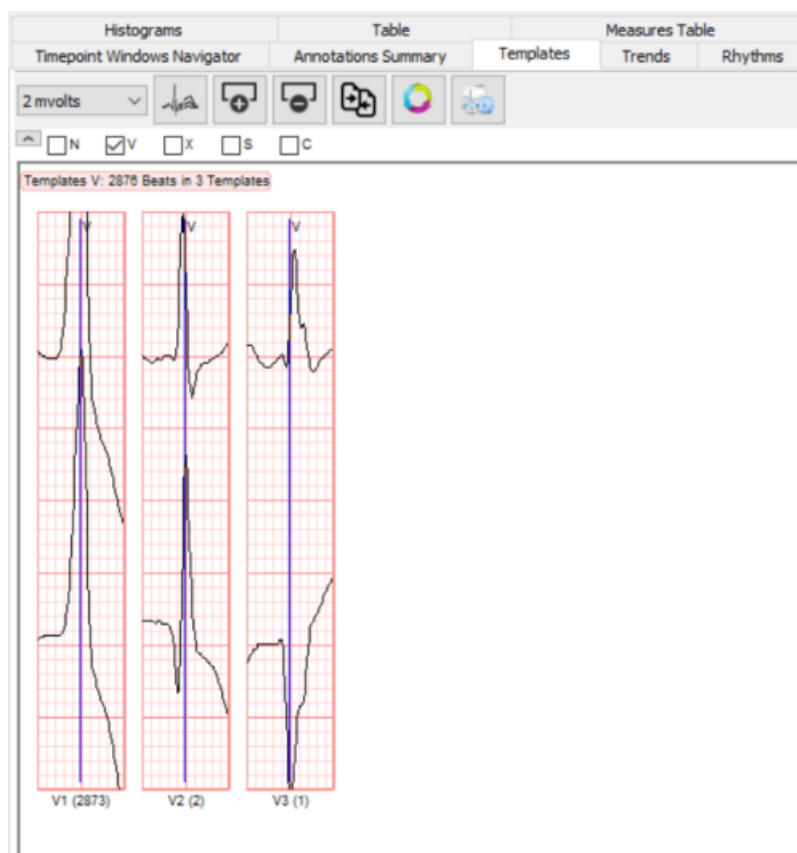
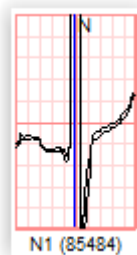


Figure 74 – Template tab display

The template ID and the overall number of beats of the Template is indicated under each template; templates are sorted by template ID.

The lower the template ID, the greater the number of beats belonging to the template.



The templates are grouped and visualized by beat label. It is possible to select the type of template to be visualized, from those identified in the continuous recording, under the toolbar.



As shown below, the information regarding the displayed templates appears at the top-left of the templates indicating the templates type, the overall number of beats that belong to the selected template type and the number of templates of the given type. Between square brackets, the ID of the selected templates is reported.

Templates V: 2876 Beats in 3 Templates [Selected Templates: V2 V3]

Information regarding the display of templates is indicated at the bottom-right of the Templates page indicating the templates displayed on the current page (e.g. from 1 to 24 of 118 are displayed as shown in the example below).

From 1 to 24 (of 118)

The Template display is interactive: clicking the primary mouse-button on a template, *Continuous ECG Viewer* or *Rhythm & Beat Editor* is updated to show the first beat that belongs to the selected template (Figure 83). It is also possible to select more templates by holding down the *CTRL* button of the keyboard or selecting several contiguous templates holding the *SHIFT* button.

In *Continuous ECG Viewer* or *Rhythm & Beat Editor*, is then possible to navigate through the ECG beats of a selected template using the navigation button, as described in section 3.4.9.



Figure 75 – Selection of template synchronized with the Rhythm & Beat Editor

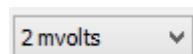
The buttons / allow to hide/show the template toolbar, described here below, thus maximizing the space for templates display.

3.13.1. Display Customization

Under the *Template* tab, the user can customize the visualization of templates by adjusting the various parameters via the toolbar buttons or drop-down menu entry.



3.13.1.1. Voltage Display Customization



The amplitude resolution for ECG display in the *Template Viewer* and in the *Move Beat Dialog* can be configured by selecting the desired amplitude resolution from the first drop-down menu from the left.

In case of squared grid (refer to Grid Options tab of 3.29.1 - Generic Display Options, starting on page 154) the drop-down menu for amplitude resolution selection is not available as the amplitude is automatically derived from the length of the template.

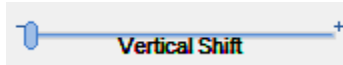
3.13.1.2. Superimposition Display



Standard/superimposed ECG waveform display can be toggled using the first toolbar button from the left.

3.13.1.3. Vertical Shift

When the superimposed mode is activated, it is possible to separate the leads using the vertical shift slider.



3.13.1.4. Number of Templates Display Customization



Increase/decrease the number of templates displayed per page by adding or removing a row.

3.13.1.5. Template Types Comparison



Single template type or multiple template types comparison can be toggled using the fourth toolbar button from the left.

3.13.2. Auto Merge Template



Upon clicking this button, templates of the same type with high correlation will be merged.

3.13.3. Template Visualization Option



Clicking on the "Edit Settings" button, the "Template Visualization Options" dialog is opened. In this dialog, the user can choose the wave complexes to be visualized. The allowed selections are: PQRST, PQRS, QRS and QRST complexes, while the default is QRS.

Note that beat detection and automatic template identification is only related to the QRS complex, P and ST complexes are not used.

The options dialog can also be invoked via the corresponding entry in the 'Options' menu (Refer to section 3.29.6).

Here it is also possible to select the leads to be visualized.

By default, all leads used in the Beat Detection process are displayed and it is possible to enable/disable the display.

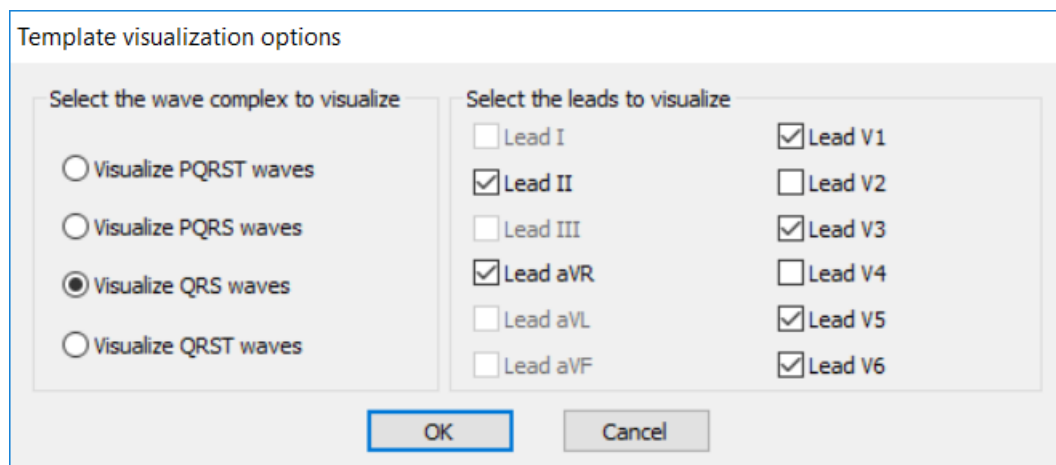


Figure 76 – Temple Visualization Options dialog. Example where Beat Detection was performed on leads II, aVR and all precordial leads (V1-V6)

3.13.4. Editing Single Template

Clicking the secondary mouse-button on a single template, the following context menu is displayed (Figure 77) where it is possible to:

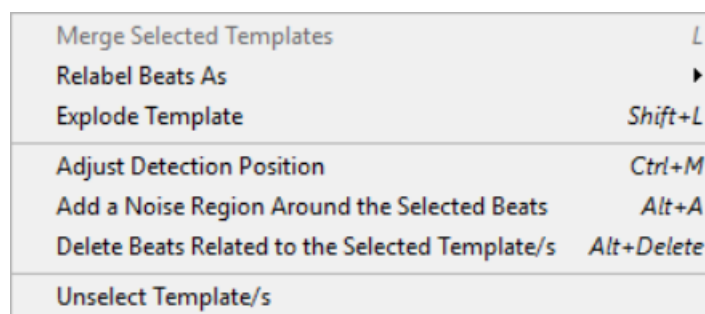


Figure 77 – Context Menu for a selection of a single template

- Relabel beats (Only if *Rhythm & Beat Editor* is available)
 - the list of available beat categories is displayed (Figure 78), these being:
 - N – Normal Beat
 - V – Ventricular Beat
 - S – Supraventricular Beat
 - C – Calibration Pulse
 - B – Beat with Bundle Branch Block
 - P – Paced Beat
 - E – Ventricular Escape Beat
 - F – Fusion Beat
 - U – Unknown Beat
 - X – Artifact

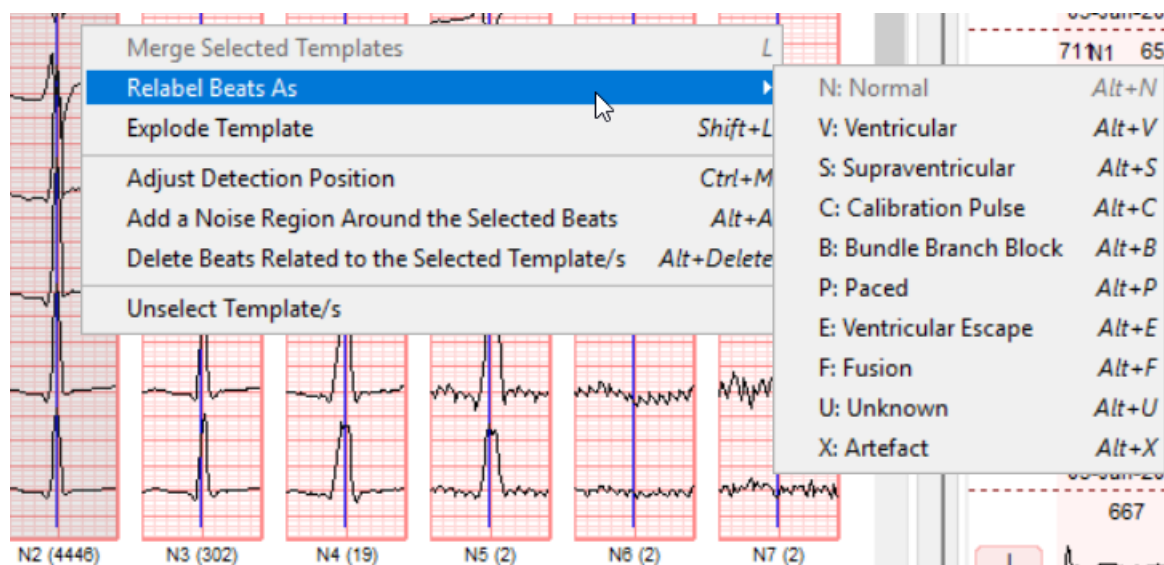


Figure 78 – Context Menu to change ECG beat labels for a single template selection

- Explode template (the current template will be exploded to generate as many templates as the number of beats within selected template).
- Adjust the beat detection position (Only if *Rhythm & Beat Editor* is available). The "Move Beat" dialog is displayed where the beat detection position can be edited as shown in Figure 79. In this dialog box, it is also possible to adjust the display organization for a more precise caliper editing.
Upon clicking the OK button, the detection position gets modified accordingly for all ECG beats belonging to the selected template.
- Add Noise Region around all ECG beats belonging to the selected template (a noise region will be entered, centered on the beat and extended in both right and left direction to the first valid beat). (Only if *Rhythm & Beat Editor* is available)
- Delete all beats belonging to the selected template (Only if *Rhythm & Beat Editor* is available).
- Unselect template.

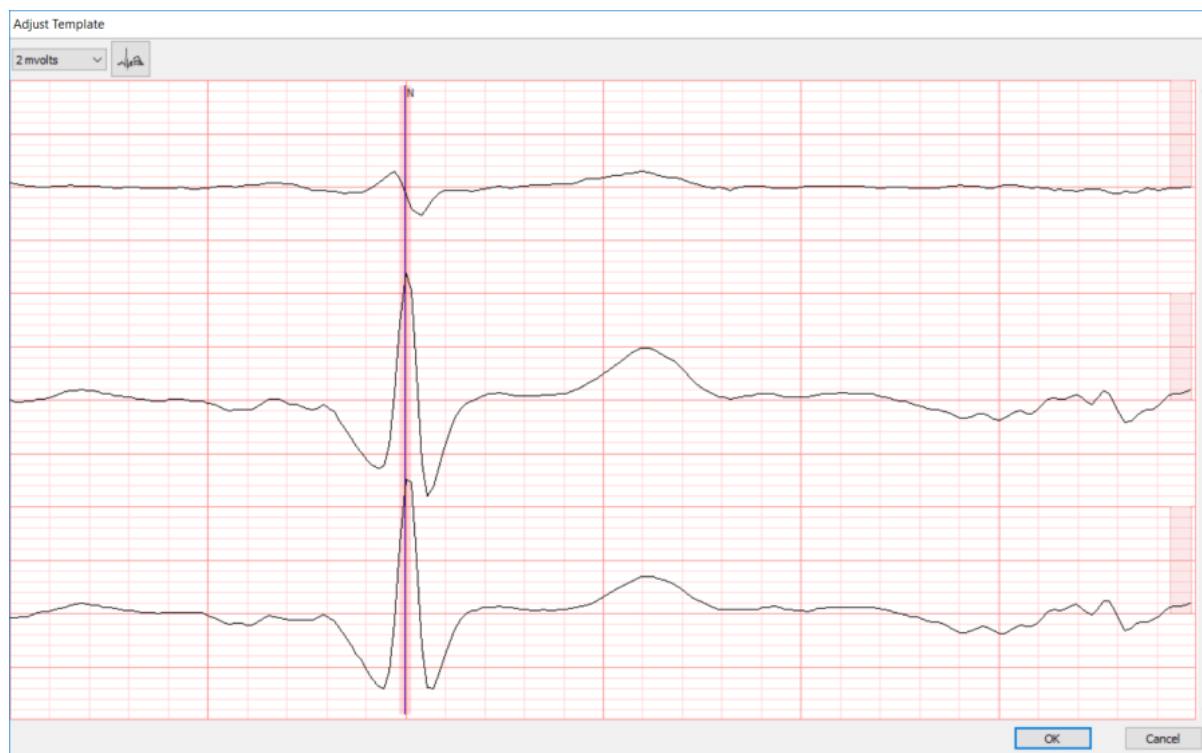


Figure 79 – Manual adjustment of a template detection position

3.13.5. Editing on a selection of templates

Clicking the secondary mouse-button on a selection of templates, the following context menu (Figure 80) is displayed, where it is possible to:

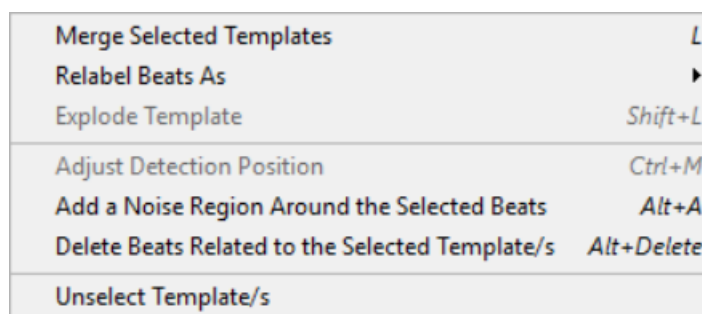


Figure 80 – Context Menu for a multiple templates selection

- Relabel beats (Only if *Rhythm & Beat Editor* is available)
 - the list of available beat categories is saved as for a single template selection (section 3.13.4 and Figure 78).
- Merge selected templates (Only if *Rhythm & Beat Editor* is available, the selected templates will be merged into a single template).
- Add Noise Region around all ECG beats belonging to the selected templates (a noise region will be entered, centered on the beat and extended in both right and left direction to the first valid beat). (Only if *Rhythm & Beat Editor* is available)
- Delete all beats belonging to the selected templates (Only if *Rhythm & Beat Editor* is available).
- Unselect templates.

3.14. Histogram Display

In the Histogram tab, the ECG beat information is provided as an interactive histogram display (Figure 81).

This display is not available in case of Multiday recordings.

Histogram allows a visual interpretation of numerical data by indicating the number of beats that lie within a range of values, called a class or a bin. The frequency of the beats that falls in each class is depicted by the use of a bar.

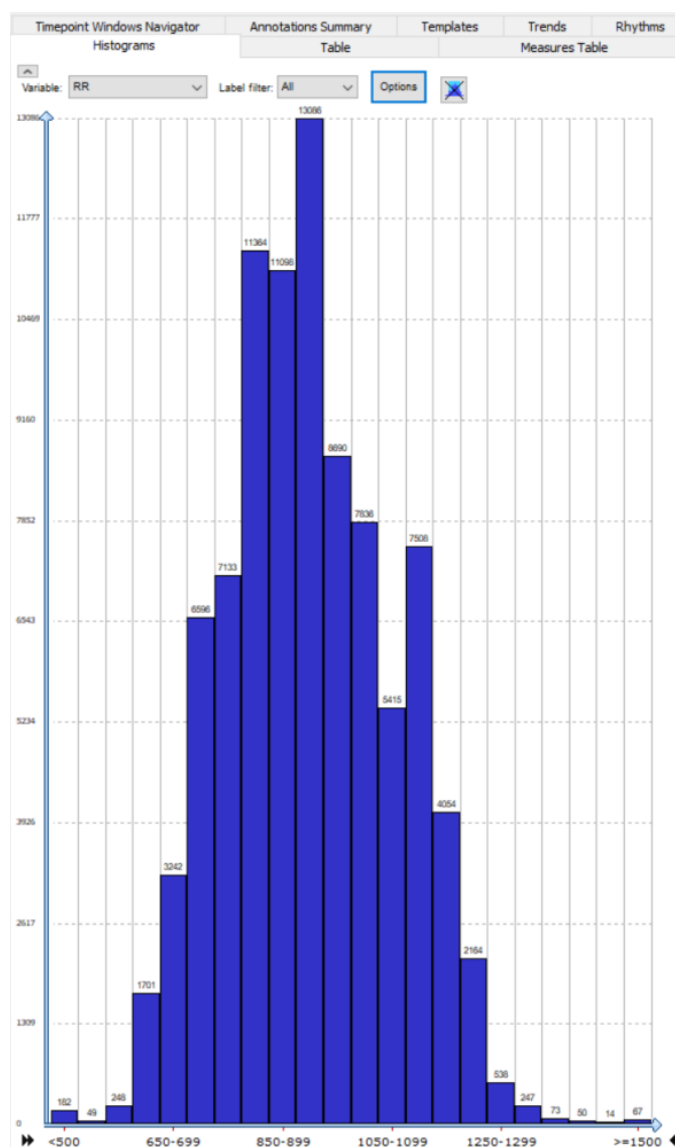


Figure 81 – Histogram tab display

The leftmost drop-down menu allows the user to set the variable on the X axis. Three entries are available:

1. RR;
2. DRR: ratio between the RR value and the previous RR value;
3. DRR2: ratio between the RR value and the value before the previous RR value.

In the "Label filter" drop-down menu on the top of the histogram (see Figure 82), it is possible to filter the beats to depict their label according. The possible entries are:

- All: all beats are displayed
- N-N: only 'N' beats followed by an 'N' beat are displayed
- V-V: only 'V' beats followed by a 'V' beat are displayed
- S-S: only 'S' beats followed by an 'S' beat are displayed
- N-V: only 'N' beats followed by a 'V' beat are displayed
- V-N: only 'V' beats followed by an 'N' beat are displayed
- N-S: only 'N' beats followed by an 'S' beat are displayed
- S-N: only 'S' beats followed by an 'N' beat are displayed
- N-U: only 'N' beats followed by an 'U' beat are displayed
- U-N: only 'U' beats followed by an 'N' beat are displayed
- N-B: only 'N' beats followed by an 'S' beat are displayed
- B-N: only 'S' beats followed by an 'N' beat are displayed
- *-N: only beats followed by an 'N' beat are displayed
- N-*: only 'N' beats are displayed
- *-V: only the beats followed by a 'V' beat are displayed
- V-*: only 'V' beats are displayed
- *-S: only beats followed by an 'S' beat are displayed
- S-*: only 'S' beats are displayed
- *-B: only beats followed by a 'B' beat are displayed
- B-*: only 'B' beats are displayed
- *-U: only beats followed by a 'U' beat are displayed
- U-*: only 'U' beats are displayed
- Not V: all Normal beats are displayed (except 'V' beats)

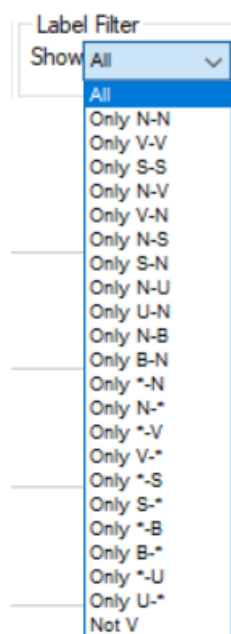






Figure 82 – "Label Filter" combo-box menu in the Histogram tab

Clicking the  icon, it is possible to reset the current histogram selection, as also by clicking the  button from *Continuous ECG Viewer* or *Rhythm & Beat Editor* toolbar.

The buttons  /  allow to hide/show the histogram buttons, described here below, thus maximizing the space for histogram display.

The Histogram display is interactive: clicking the primary mouse-button on a bar of the histogram, the *Continuous ECG Viewer* or the *Rhythm & Beat Editor* can be updated to show the first ECG beat that lies in the selected range (Figure 83). It is also possible to select more than one consecutive bars.

In *Continuous ECG Viewer* or *Rhythm & Beat Editor*, it is then possible to navigate through the selected ECG beats using the navigation button as described in section 3.4.9.

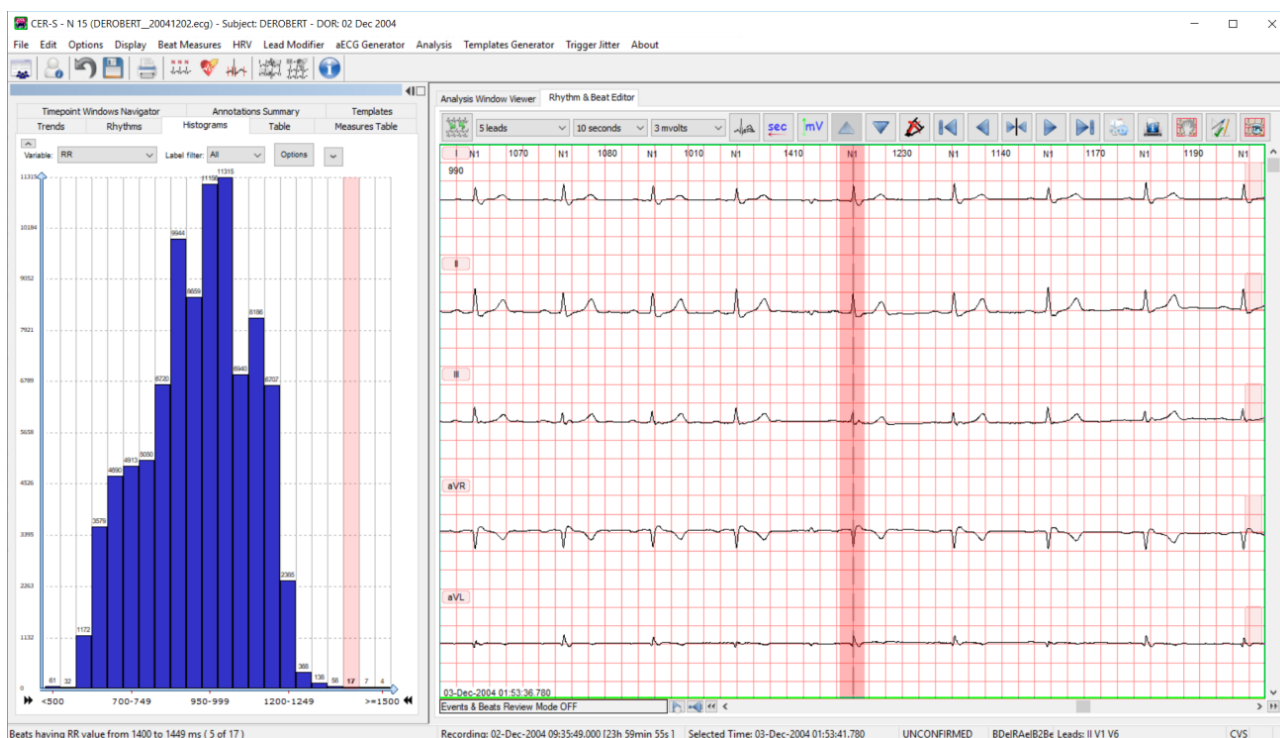



Figure 83 – Selection of a histogram bar synchronized with the Rhythm & Beat Editor

3.14.1. Histogram Options

The Histogram Options dialog box is invoked by clicking the  button, or via the corresponding entry in the 'Options' menu (see ref. 3.29.6).

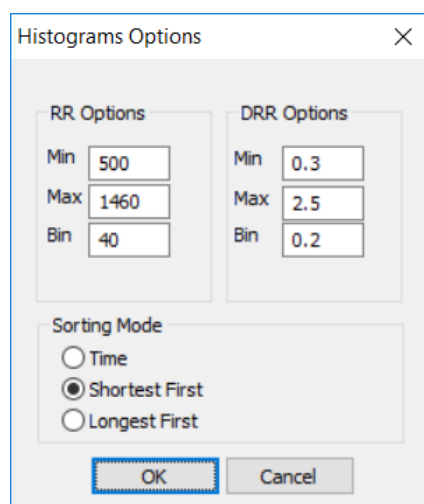


Figure 84 – Options dialog box under the Histogram tab

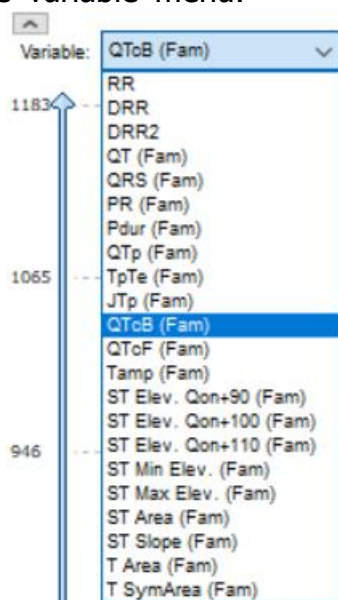
In this dialog box, it is possible to set up max-min values and the number of bins for RR and DRR variables.

It is also possible to change the order of the selected beats:

- Sorted by time position
- Sorted by value, shortest first
- Sorted by value, longest first

3.14.2. Families-Histogram

In case the "Beat Measures Analysis" has been performed, it is possible to select measured-related items. from the 'variable' menu.



Families-Histogram allows a visual interpretation of numerical data by indicating the number of families that lie within a range of values, called a class or a bin. The frequency of the beats that fall in each class is depicted by a bar.

The Histogram display is interactive: clicking the primary mouse-button on a bar of the histogram, the "Adjust Measures Dialog" is displayed showing the families that lie in the selected range. It is also possible to select more than one consecutive bars (Figure 85).

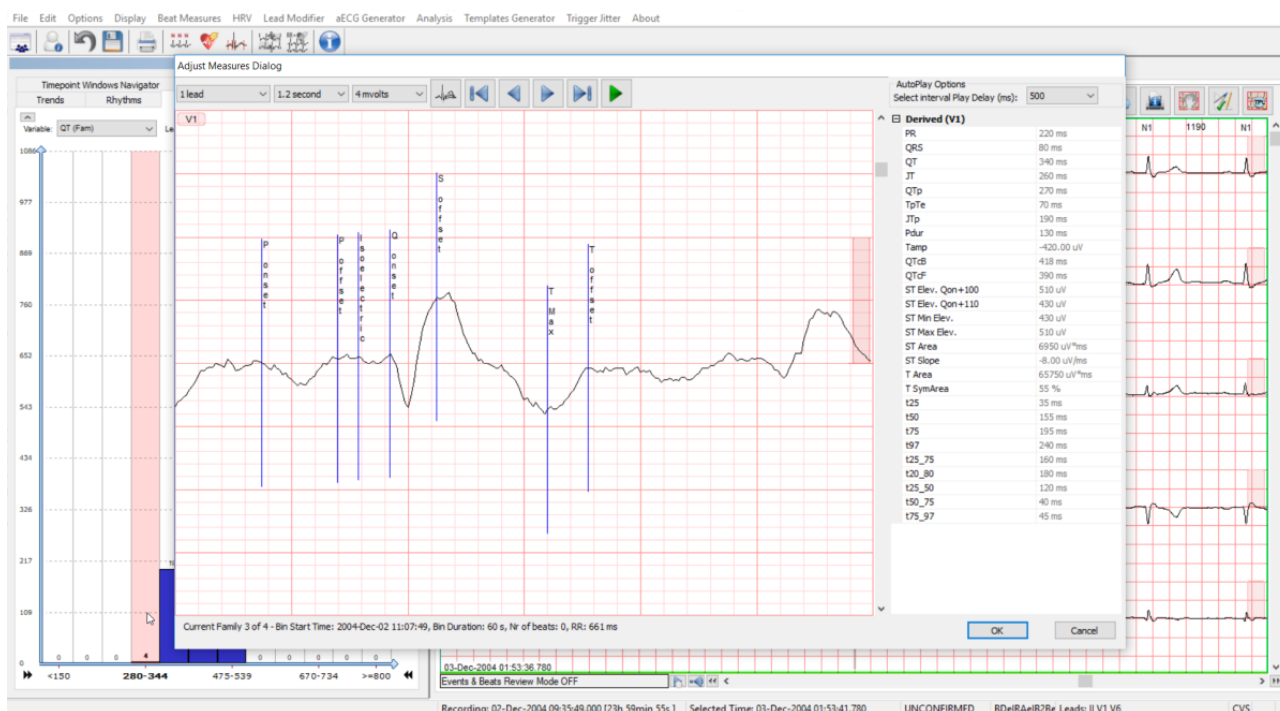
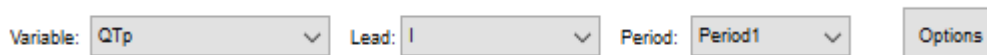


Figure 85 – Families-Histogram: selection of families having a QT value between 280 and 344 on Lead V1

When a measure-item is selected from the 'variable' menu, the 'label filter' menu is substituted by the 'Lead' and 'Period' menus.



Available leads are those been measured, selected in the Beat Measures options, with the addition of VM (Vector Magnitude lead).

The period menu is available only in case of multi-period beat measure analysis (ref. 3.21).

3.15. Rhythms Display

Under the Rhythms tab, the RR/HR average trend can be seen and the rhythm annotations information is provided as an interactive histogram display (Figure 86).

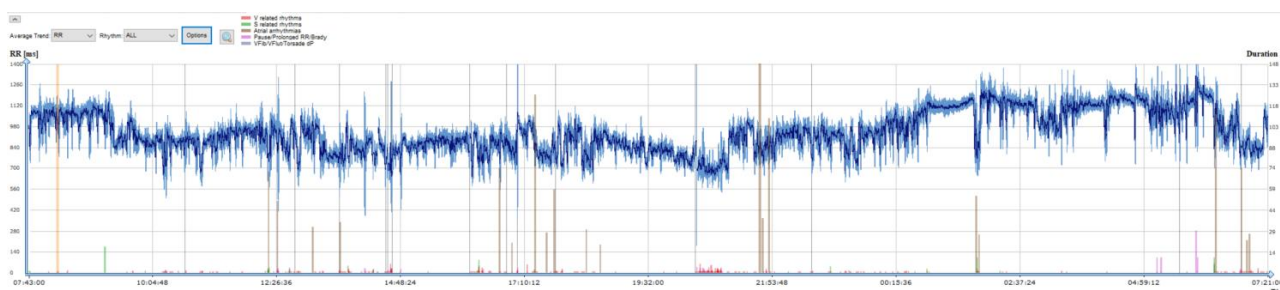
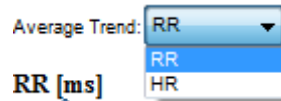


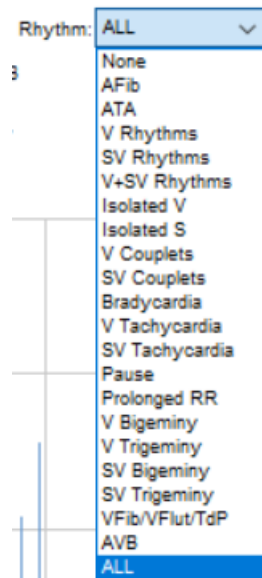
Figure 86 – Rhythms tab display

The value represented on the X axis is the time, and the Y variable changes according to the selected rhythm, in the drop-down menu.

From the "average trend" drop-down menu, it is possible to select the type of the displayed average trend (RR or HR).




From the “Rhythm” drop-down menu, is possible to select the rhythms to display in the plot.



Here is the list of selectable items with the related variable in the Y axis, with unit of measure, within brackets:

- None: No rhythm selected, show only average trend
- AFib: atrial fibrillation (duration, s)
- ATA: atrial fibrillation, atrial flutter and atrial tachycardia (duration, s)
- V Rhythms: isolated ventricular beats, ventricular couplets and run (number of beats)
- SV Rhythms: isolated supraventricular beats, supraventricular couplets and run (number of beats)
- V + SV Rhythms: ventricular and supraventricular rhythms shown together (number of beats)
- Isolated V: isolated ventricular beats (number of beats)
- Isolated S: isolated supraventricular beats (number of beats)
- V Couplets: ventricular couplets (number of beats)
- SV Couplets: supraventricular couplets (number of beats)
- Bradycardia (average RR, ms)
- V Tachycardia: ventricular tachycardia (average HR, bpm)
- SV Tachycardia: supraventricular tachycardia (average HR, bpm)
- Pause (duration, s)
- Prolonged RR (duration, s)
- V Bigeminy: ventricular bigeminy (duration, s)
- V Trigeminy: ventricular trigeminy (duration, s)
- SV Bigeminy: supraventricular bigeminy (duration, s)
- SV Trigeminy: supraventricular trigeminy (duration, s)
- VFib/VFlu/TdP: ventricular fibrillation, ventricular flutter and Torsade de Pointes (duration, s)
- AVB: atrioventricular blocks (duration, s)

- First-degree Atrioventricular Block
- Type 1 Second-degree Atrioventricular Block
- Type 2 Second-degree Atrioventricular Block
- Third-degree Atrioventricular Block
- 'ALL': display all rhythm annotations (duration, s)

The button  allows to activate the zoom feature, refer to section 3.15.1 for possible settings, enabling a context view at the bottom showing the entire trends, while on the upper part the zoomed trends is visualized, see Figure 87. The context view can be deactivated accessing the rhythm display options.

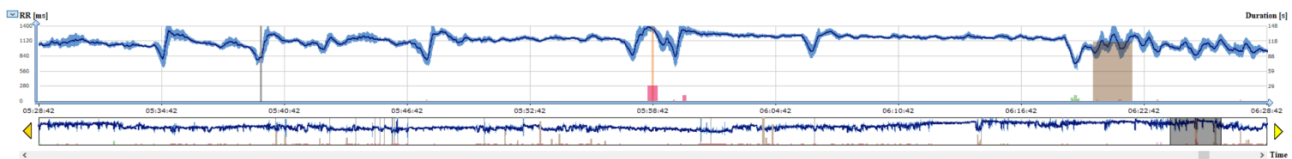






Figure 87 – Rhythm display with zoom activated, with resolution of one hour

Scrolling is possible using:

- the horizontal scrollbar
- drag & drop action on the gray highlighted area, using the primary mouse button
- the yellow left and right arrows beside the context display  / 

The buttons  /  allow to hide/show the Rhythms buttons, described here below, thus maximizing the space for rhythms display.

The Rhythms display is interactive: clicking the primary mouse-button on an event in the rhythms tab, the *Continuous ECG Viewer* or the *Rhythm & Beat Editor* is updated to show the selected event (Figure 88).

While, clicking the secondary mouse-button on trend, the *Continuous ECG Viewer* or the *Rhythm & Beat Editor* is updated to show the selected position.

The current position shown in the *Continuous ECG Viewer* or the *Rhythm & Beat Editor* is highlighted with a yellow bar on the rhythms tab.



Figure 88 – Selection of a bar in the "Rhythms Display" synchronized with the Rhythm and Beat Editor

It is also possible to select more than one rhythm annotation by drawing a rectangle on the desired annotations: all the rhythms included (or partially included) in the rectangle will be selected, as shown in Figure 89 where 16 annotations have been selected.

By clicking the secondary mouse button on an active selection (see Figure 90), it is possible to:

- enter a rhythm annotation from those manually insertable (this is only possible if "ALL" entry is selected from "Rhythm" drop-down menu; if "AFib", "ATA", "VFib/VFlut/TdP" entries are selected, only the related subset of the insertable annotations will be visible):
 - Atrial Fibrillation
 - Atrial Flutter
 - Atrial Tachycardia
 - Ventricular Fibrillation
 - Ventricular Flutter
 - Torsade de Pointes
- Enter an AVB (this is only possible if "ALL" or "AVB" entries are selected from "Rhythm" drop-down menu)
 - First-degree Atrioventricular Block
 - Type 1 Second-degree Atrioventricular Block
 - Type 2 Second-degree Atrioventricular Block
 - Third-degree Atrioventricular Block
- enter a noise region
- delete selected events, in case the selection was performed including at least a rhythm annotation

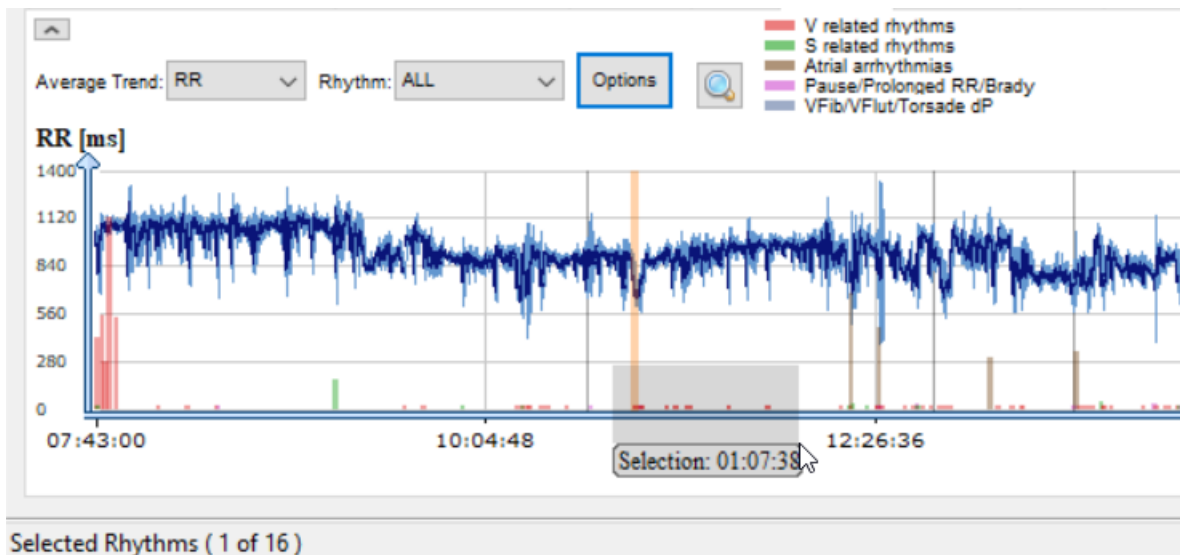


Figure 89 – Multiple rhythm events selection on "Rhythms Display"

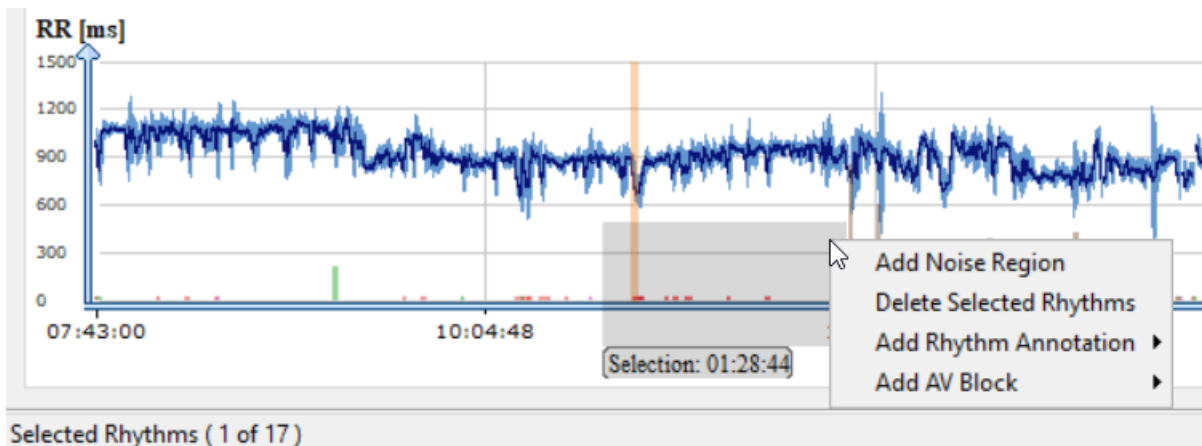


Figure 90 – Selection on "Rhythms Display", allows entering a noise region, a rhythm annotations or the deletion of the selected events

3.15.1. Rhythms in Multiday analysis

In case of multiday recordings, the rhythms display is optimized for the report of the rhythm annotations subset that can be computed by multiday analysis, namely:

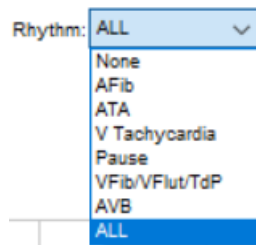
- Pauses
- Atrial Fibrillation
- Ventricular Tachycardia

Rhythm annotations that can be manually inserted, namely



- Pauses
- Atrial Fibrillation
- Ventricular Tachycardia
- Other ATA: atrial flutter and atrial tachycardia
- Ventricular Fibrillation, Ventricular Flutter and Torsade de Pointes
- Atrioventricular blocks

For this reason the Rhythm drop-down menu is reduced to include only the above entries. Here the list of selectable items with the related variable in the Y axis, with unit of measure, within brackets::

- None: No rhythm selected, show only average trend
- AFib: atrial fibrillation (duration, s)
- ATA: atrial fibrillation, atrial flutter and atrial tachycardia (duration, s)
- V Tachycardia: ventricular tachycardia (average HR, bpm)
- Pause (duration, s)
- VFib/VFlu/TdP: ventricular fibrillation, ventricular flutter and Torsade de Pointes (duration, s)
- AVB: atrioventricular blocks (duration, s)
 - First-degree Atrioventricular Block
 - Type 1 Second-degree Atrioventricular Block
 - Type 2 Second-degree Atrioventricular Block
 - Third-degree Atrioventricular Block
- 'ALL': display all rhythm annotations (duration, s)



Differently from standard Rhythms, in case of multiday recordings, two levels of zoom are available:

-  activate the zoom to 24 hours
-  activate the additional zoom, with configurable length on rhythm display options.

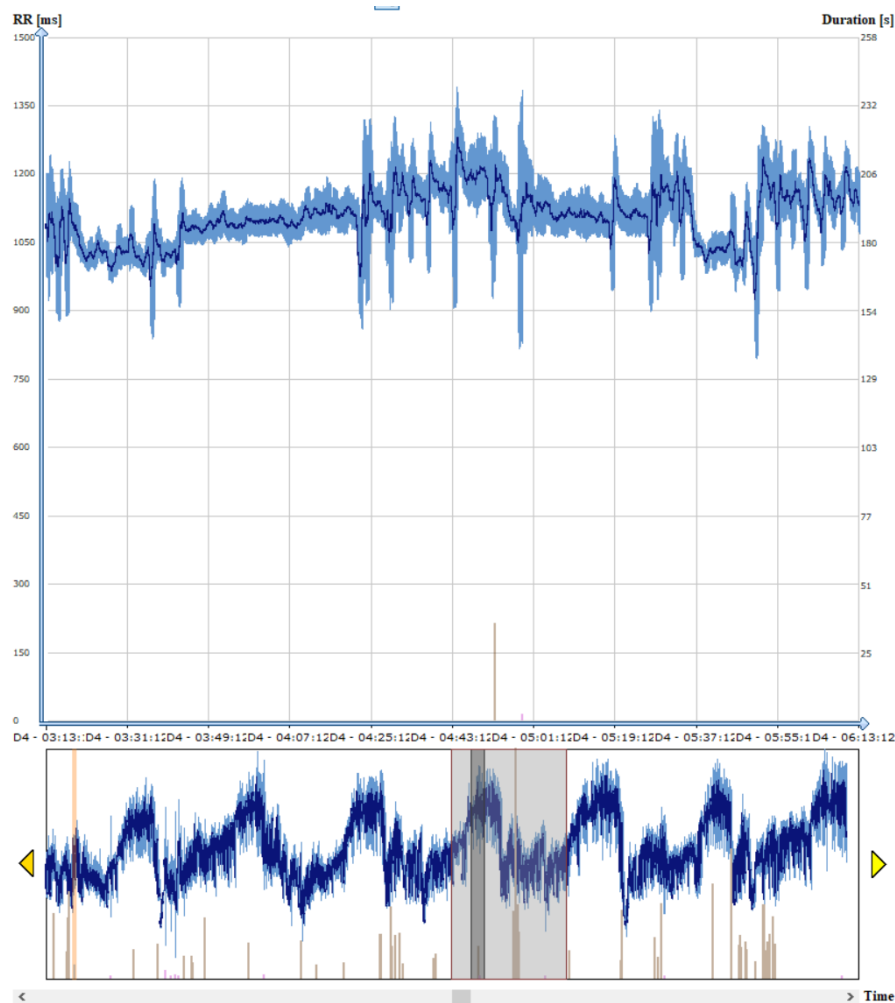


Figure 91 – Multiday Rhythm display with both zooms activated, with resolution of two hours.

By clicking the secondary mouse button on an active selection (see Figure 92), it is possible to:

- enter a rhythm annotation from those manually insertable (this is only possible if "ALL" entry is selected from "Rhythm" drop-down menu; if "AFib", "ATA", "VFib/VFlut/TdP" entries, are selected, only the related subset of the insertable annotations will be visible):
 - Atrial Fibrillation
 - Atrial Flutter
 - Atrial Tachycardia
 - Ventricular Fibrillation
 - Ventricular Flutter
 - Torsade de Pointes
- enter an AVB (this is only possible if "ALL" or "AVB" entries are selected from "Rhythm" drop-down menu)
 - First-degree Atrioventricular Block
 - Type 1 Second-degree Atrioventricular Block
 - Type 2 Second-degree Atrioventricular Block
 - Third-degree Atrioventricular Block
- enter a noise region

- delete selected events, in case the selection was performed including at least a rhythm annotation
- select a detailed analysis segment to cut and export; it will then be possible to perform standard Beat Detection and Rhythm analysis and that segment on a new CER-S session.

The maximum length of a detailed analysis segment is 24 hours and will be automatically reduced to the first 24 hours, in case a selection longer than 24 hours was inserted.

Selected detailed analysis segments will be exported in AMPS compressed format (ACecg).

Upon selecting the segment-related item, a new dialog (Figure 93) allowing to specify the name of the segment is displayed. This label will be placed in the Visit field of the exported record segment. In case a Visit label is already present in the current multiday continuous ECG recording, the Visit label of the exported record segment will be the concatenation of the two, divided by the text " - ".

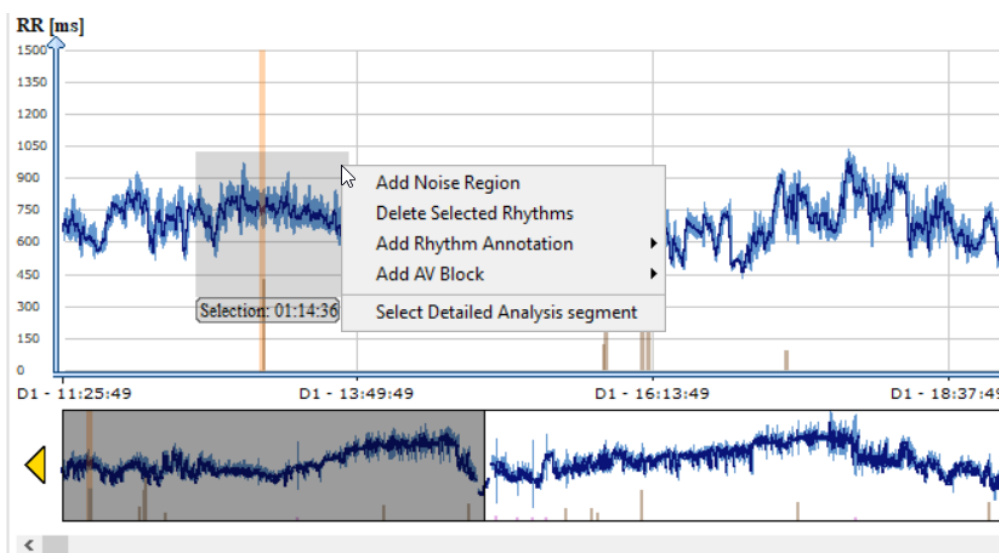



Figure 92 – Selection on "Rhythms Display", allows entering a noise region, a rhythm annotations, the deletion of the selected events and the selection of shorter detailed analysis segment to cut

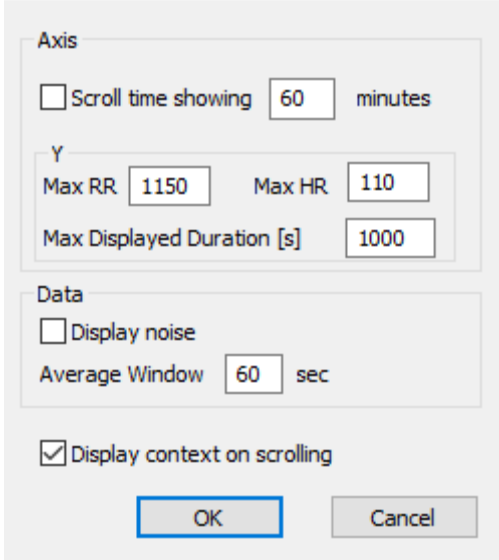
Figure 93 – Detailed Analysis segment label entry

To export selected detailed analysis segments, select "Cut and Export Record" entry from File menu.

3.15.2. Rhythms Display Options

The Rhythm Display Options dialog is invoked by clicking the  button, or via the corresponding entry in the 'Options' menu (see ref. 3.29.6).

Rhythms Page Options



The dialog box is titled 'Rhythms Page Options'. It contains three main sections: 'Axis', 'Y', and 'Data'. The 'Axis' section has a checkbox for 'Scroll time showing' and a text box with '60' and the unit 'minutes'. The 'Y' section has two text boxes: 'Max RR' with '1150' and 'Max HR' with '110', and a text box for 'Max Displayed Duration [s]' with '1000'. The 'Data' section has a checkbox for 'Display noise' and a text box for 'Average Window' with '60' and the unit 'sec'. At the bottom, there is a checked checkbox for 'Display context on scrolling' and two buttons: 'OK' and 'Cancel'.

Axis

☐ Scroll time showing 60 minutes

Y

Max RR 1150 Max HR 110

Max Displayed Duration [s] 1000

Data

☐ Display noise

Average Window 60 sec

☒ Display context on scrolling

OK Cancel

In this dialog is possible to:

- Zoom the displayed time to a given window (default 60 minutes) enabling the scrolling of the X axis
- Set the maximum Y axis value in case of RR or HR
- Set maximum displayable value when the Y axis represents the duration of a rhythm annotation (see Figure 94 for example)
- Choose whether the noise regions should be displayed or not;
- Set the length of the window used to compute the average RR/HR;
- Choose whether to display the context view of the whole graph in case of time-scrolling or not.

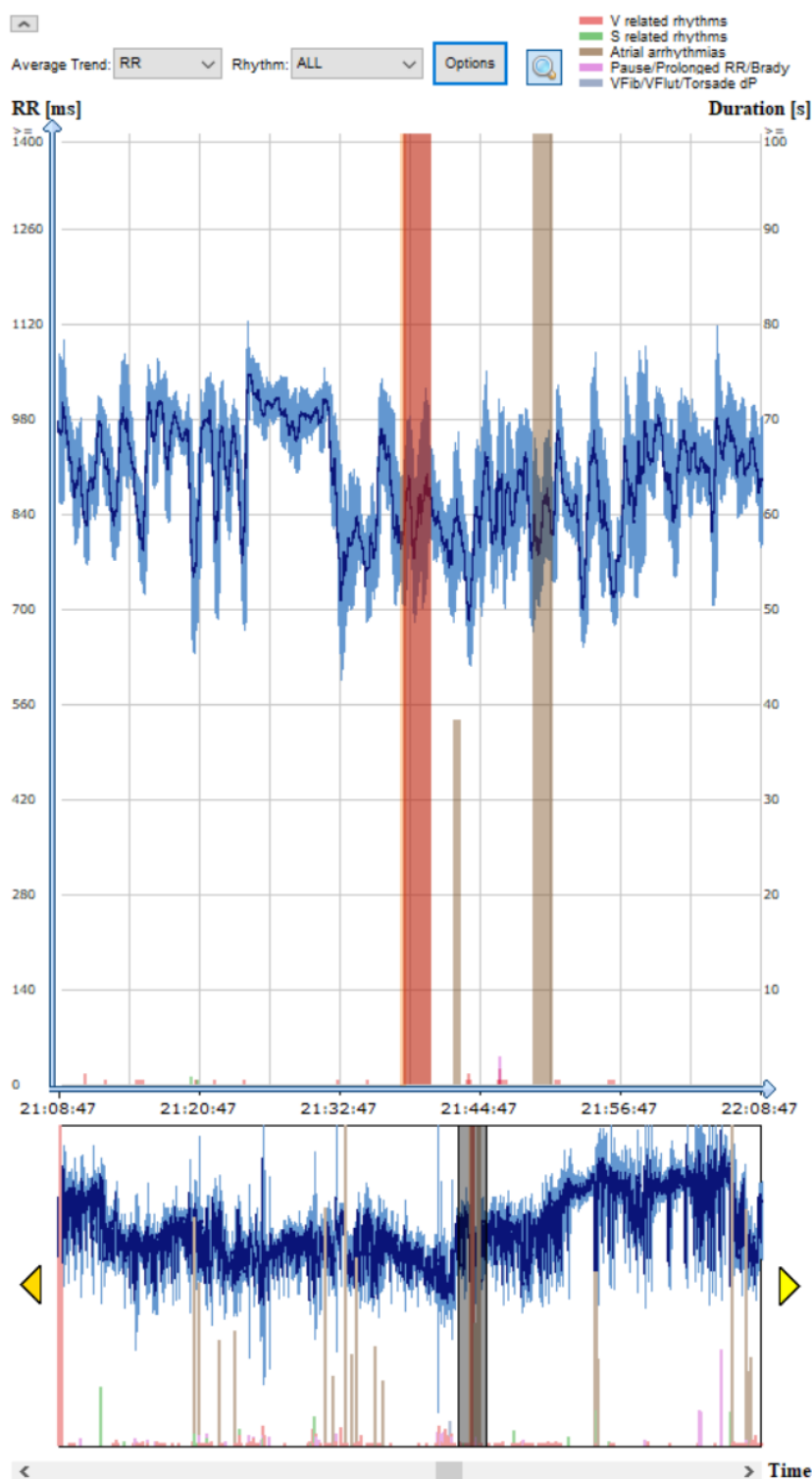


Figure 94 – Example of a "Rhythms Display" with scrolling enabled on a 60 minutes length window, displaying the context view. The noise is shown (in grey) and the maximum displayable duration value is set to 100 seconds

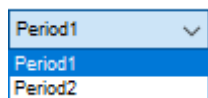
3.16. Measures Table Display

In the Measures Table tab (Figure 95), the families' measure information is provided in an interactive table. This tab is available only with the *Beat Measure Platform* (refer to section 3.21 for details).

This display is not available in case of Multiday recordings.

The table reports all measures of all measured leads with the addition of VM, for each family (one per row).

In case of multiple-periods analysis, it is possible to switch between different periods via a dedicated menu.

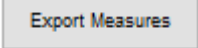


Timepoint Windows Navigator			Annotations Summary		Templates	Trends	Rhythms	Histograms	Table	Measures Table			
<div>Export Measures</div>													
#	Bin	# Beats	RR	QT (VM)	QT (V1)	QT (V2)	QT (V3)	QT (V4)	QT (V5)	QT (V6)	QRS (VM)	QRS A	
1	09:35:49 - 09:36:49	32	938	420	435	455	470	490	405	415	145		
2	09:36:49 - 09:37:49	66	919	370	405	430	455	295	415	410	40		
3	09:37:49 - 09:38:49	67	888	410	415	455	460	395	410	400	145		
4	09:38:49 - 09:39:49	71	846	400	420	425	435	330	400	395	145		
5	09:39:49 - 09:40:49	73	817	400	410	410	415	435	395	395	145		
6	09:40:49 - 09:41:49	79	766	400	395	405	415	425	395	385	145		
7	09:41:49 - 09:42:49	81	733	395	375		410	405	365	385	145		
8	09:42:49 - 09:43:49	80	754	385	400	400	405	435	375	375	145		
9	09:43:49 - 09:44:49	74	811	385	400	405	410	295	395	375	145		
10	09:44:49 - 09:45:49	77	782	410	415	415	420	450	395	395	145		
11	09:45:49 - 09:46:49	76	781	420	400	395	440	315	385	385	145		
12	09:46:49 - 09:47:49	77	784	370	415	420	425	415	395	395	145		
13	09:47:49 - 09:48:49	67	825	425	430	375	450	415	390	390	50		
14	09:48:49 - 09:49:49	67	889	470	465	495	480	475	425	450	205		
15	09:49:49 - 09:50:49	78	775	415	380	430	435	255	375	375	140		
16	09:50:49 - 09:51:49	72	813	395	400	390	400	455	405	380	150		
17	09:51:49 - 09:52:49	81	736	410	400	410	425	430	375	385	135		
18	09:52:49 - 09:53:49	76	794	430	385	430	425	460	370	380	145		
19	09:53:49 - 09:54:49	64	912	420	420	375	455	370	395	390	145		
20	09:54:49 - 09:55:49	73	820	370	390	385	380	370	400	400	140		
21	09:55:49 - 09:56:49	72	804	400	405	405	435	445	380	395	145		
22	09:56:49 - 09:57:49	74	808	395	400	395	405	400	380	385	145		
23	09:57:49 - 09:58:49	71	849	400	410	415	425	435	380	385	145		
24	09:58:49 - 09:59:49	70	857	390	405	405	415	430	390	385	140		
25	09:59:49 - 10:00:49	71	843	390	405	410	410	425	385	390	140		
26	10:00:49 - 10:01:49	72	832	380	410	395	400	385	395	400	145		
27	10:01:49 - 10:02:49	73	807	375	415	410	415	310	405	395	145		
28	10:02:49 - 10:03:49	71	839	400	415	405	410	480	385	390	145		
29	10:03:49 - 10:04:49	71	840	400	415	410	425	445	400	395	145		
30	10:04:49 - 10:05:49	71	844	400	405	410	415	420	395	395	145		
31	10:05:49 - 10:06:49	68	882	400	405	415	420	450	390	395	140		
32	10:06:49 - 10:07:49	69	876	400	410	410	415	435	395	400	140		
33	10:07:49 - 10:08:49	67	888	405	415	415	420	380	415	410	145		
34	10:08:49 - 10:09:49	67	896	405	420	415	420	365	415	405	145		
35	10:09:49 - 10:10:49	68	888	400	410	410	425	590	405	400	140		
36	10:10:49 - 10:11:49	67	886	410	415	415	420	395	410	405	145		
37	10:11:49 - 10:12:49	70	842	395	415	415	415	460	420	400	145		
38	10:12:49 - 10:13:49	76	774	390	385	425	405	390	395	400	135		
39	10:13:49 - 10:14:49	74	815	385	415	425	415	375	400	395	145		
40	10:14:49 - 10:15:49	74	809	370	380	380	420	370	415	395	45		
41	10:15:49 - 10:16:49	80	742	390	375	390	405	415	375	370	145		
42	10:16:49 - 10:17:49	70	860	375	395	410	415	310	395	395	145		
43	10:17:49 - 10:18:49	68	882	395	420	430	450	330	405	400	145		
44	10:18:49 - 10:19:49	72	849	385	435	395	435	320	405	405	145		

Figure 95 – "Measures Table"

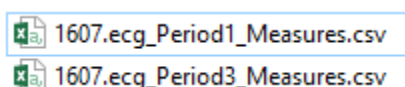
The Table display is interactive: clicking the primary mouse-button on any given value, will load the Adjust Measure dialog, where it is possible to manually adjust the ECG annotations, refer to section 3.21.3 starting on page 125 for all the details.

3.16.1. Export Measures Table

The button  allows to export the content of the table (Figure 96) in a .csv file such that one file is created for each period.

Once the button is pressed, the user is prompted to select the destination folder.

The file name will be: *RecordName_PeriodName_Measures.csv* and the values are separated by a semicolon.



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Family	Bin	Beats	RR	QT (VM)	QT (I)	QT (II)	QRS (VM)	QRS (I)	QRS (II)	PR (VM)	PR (I)	PR (II)
2	1	06:49:13 - 06:51:13	102	718	332		344	80		76	142		146
3	2	06:51:13 - 06:53:13	175	693	340		340	84		76	142		140
4	3	06:53:13 - 06:55:13	161	729	338		342	82		76	144		152
5	4	06:55:13 - 06:57:13	177	683	344		350	82		80	138		140
6	5	06:57:13 - 06:59:13	133	983	344		428	82		76	136		158
7	6	06:59:13 - 07:01:13	144	834	360	366	362	86	74	80	148	122	150
8	7	07:01:13 - 07:03:13	131	915	370		374	86		80	150		154
9	8	07:03:13 - 07:05:13	133	897	374	382	376	86	76	80	152	128	156
10	9	07:05:13 - 07:07:13	132	911	374	378	376	86	76	80	152	132	156
11	10	07:07:13 - 07:09:13	134	898	374		376	86		78	154		158
12	11	07:09:13 - 07:11:13	129	929	376	384	380	86	76	78	152	128	156
13	12	07:11:13 - 07:13:13	125	958	382	386	384	86	76	78	152	130	156
14	13	07:13:13 - 07:15:13	122	979	384	396	386	86	76	78	154	134	156
15	14	07:15:13 - 07:17:13	122	990	388	396	388	88	76	78	152	136	156
16	15	07:17:13 - 07:19:13	117	1018	388	396	390	88	76	78	150	130	154
17	16	07:19:13 - 07:21:13	124	969	384	392	386	86	76	80	152	134	154
18	17	07:21:13 - 07:23:13	128	937	382	392	384	86	76	78	158	148	162
19	18	07:23:13 - 07:25:13	135	887	378	384	378	86	76	80	156	142	158
20	19	07:25:13 - 07:27:13	136	886	372	380	372	86	76	80	154	136	156

Figure 96 – Example of measures .csv file, imported in a spreadsheet application

3.17. HRV Menu

From this menu is possible to view and export results of HRV time domain analysis which is automatically computed throughout the recording in windows of 5 minutes length.

In addition, summary results for Day and night periods and the overall recording are also provided.



3.18. Lead Modifier Menu

From this menu (see Figure 97) the user can modify the layout of the continuous ECG recording in one of the following ways:

- Remove aVR, aVL and aVF leads,
- Remove lead III, aVR, aVL and aVF
- Reconstruct limb leads,
- Hide Lead Fail segments,
- Reconstruct chest leads, CL, CR, CF

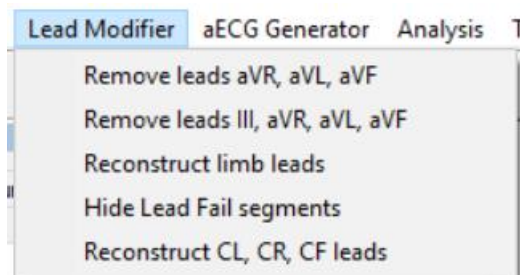


Figure 97 – "Lead Modifier" Menu

The editing of leads layout is possible because the 6 limb leads (I, II, III, aVR, aVL and aVF) are redundant. Only 2 of these leads are required to regenerate the 4 missing ones.

For this reason, with the menu entry "Reconstruct limb leads", it is possible to regenerate 4 missing limb leads, starting with 2 leads from I, II, III, aVR, aVL and aVF.

With the second option, it is possible to reduce the number of leads so that the size of the output record exported by CER-S is smaller (30% approximately) than the original 12 Leads recording.

In Figure 98, an example of a 12-lead ECG reduced to 9 and 8 leads is displayed.

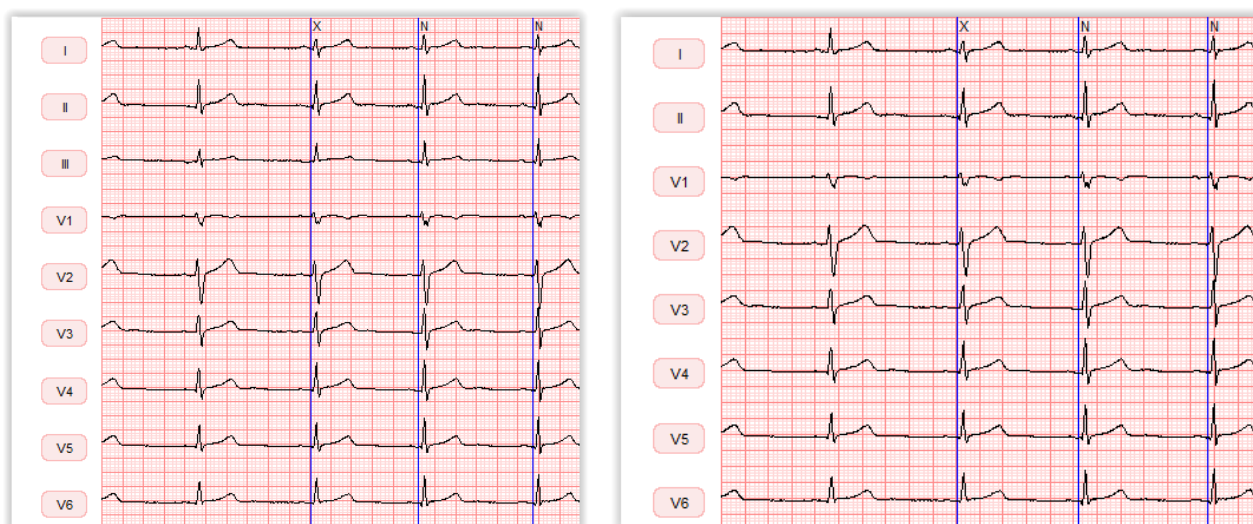


Figure 98 – Example of leads removal: "aVR, aVL and aVF lead removal", "aVR, aVL, aVF and lead III removal" shown respectively on the left and right

3.19. aECG Generator (Pollux) Menu

This menu is used for the generation of the aECG FDA HL7 XML v.2 format.

Here it is possible to load the different components that characterize the aECG FDA HL7 format:

- Timepoint Windows
- Analysis Windows
- Protocol Events

Once the components are loaded (at least one AW), it is possible to generate the aECG FDA HL7 record.

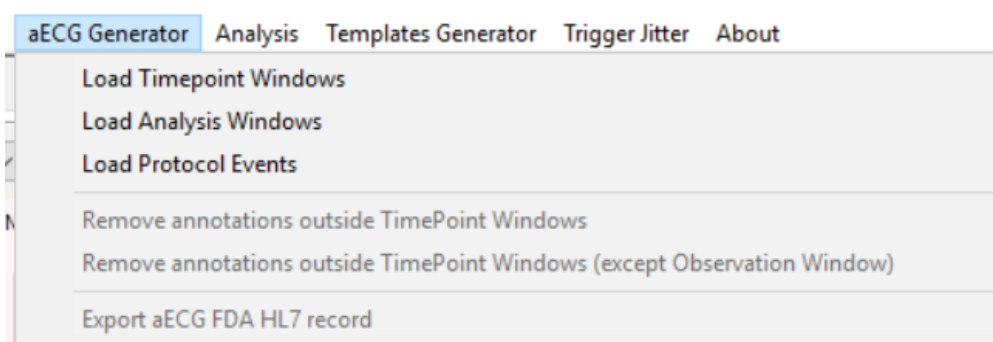


Figure 99 – "aECG Generator" Menu

3.19.1. Timepoint Windows

By clicking the first entry 'Load Timepoint Windows', a new dialog (Figure 100) is loaded where the location of the CSV timepoint file and Timepoint Window size must be specified.

The location of the file can be selected by clicking the  button and selecting the CSV file in the dialog box shown in Figure 101.

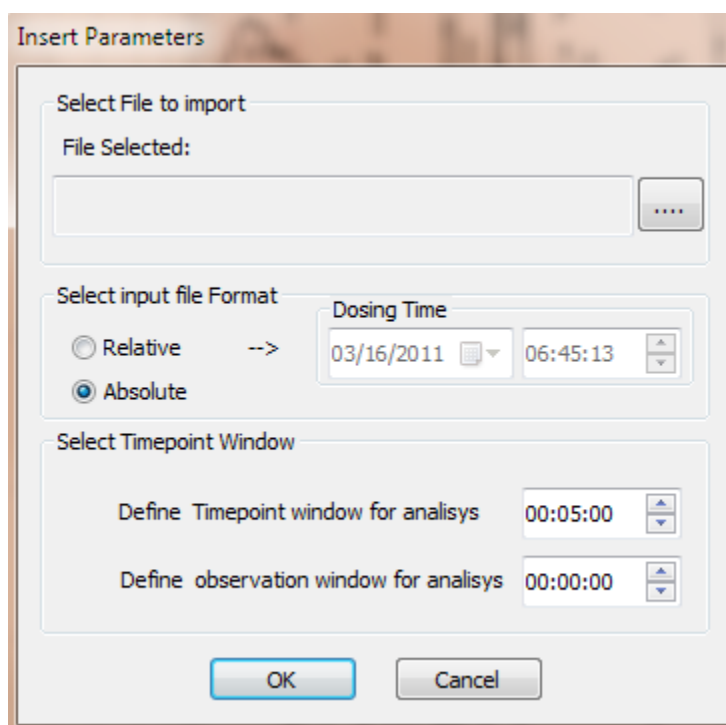
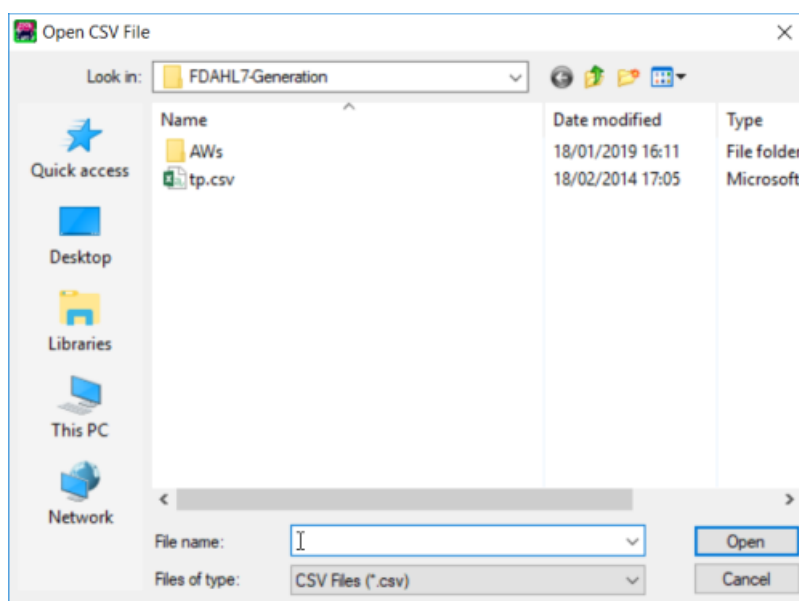
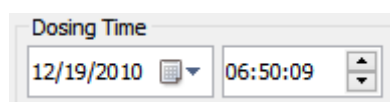


Figure 100 – Timepoint Windows settings*Figure 101 – Timepoint Windows file selection*

CER-S supports two CSV Timepoint file formats:

- **Relative Timepoints:** In this format, timepoints are expressed as time and can be either positive or negative. In this case an additional parameter is required: the dosing time that all relative timepoints refer to. Dosing time is by default set to the start time of the continuous ECG record and can be edited by either entering the value directly using the keyboard or by clicking the up/down arrows with the help of a mouse.



Shown here (below) is an example of a CSV Timepoint file with 4 timepoints, expressed in relative times: 1 hour and thirty minutes before dosing, dosing time, 1 hour after dosing and 5 hours post-dose, respectively.

```
-01:30:00
00:00:00
01:00:00
05:00:00
```

- **Absolute Timepoints:** In this format, timepoints are expressed in time/date format (separated by the semicolon ";" character). In this case no dosing time is required. Here is an example of a CSV Timepoint file with 3 absolute timepoints.

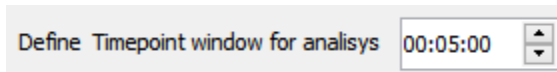
```
06:52:00;19/12/2010
07:52:00;19/12/2010
11:52:00;19/12/2010
```

For both file formats, it is possible to set the window size (in second) and the timepoint label. These values, both optional, must be set after the time (absolute or relative), separated by a semicolon character.

Here an example of a CSV Timepoint file with 3 absolute timepoints. The first and the third have the window size (30 and 45 seconds respectively) set. A label is set for all:

```
06:52:00;19/12/2010;30;label1
07:52:00;19/12/2010;;label2
11:52:00;19/12/2010;45;label3
```

If the Timepoint Window size is not set in the .csv file, it shall be entered by either typing the value directly using the keyboard or by clicking the up/down arrows with the mouse



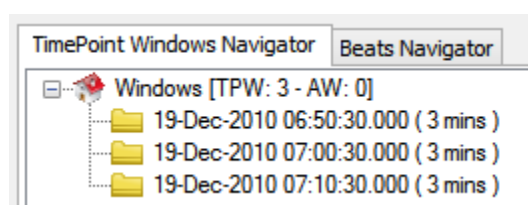
In case the window size is provided in the CSV Timepoint file, the value will override the one specified in the software dialog.

In case the CSV Timepoint file is not in a valid format, the timepoints will not be loaded.

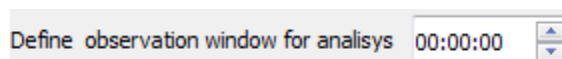
Note that the timepoint window is centered on the nominal timepoint. Thus by specifying for example a timepoint at 08:00:00 and a timepoint window size of 5 minutes, the timepoint window will start at 07:57:30 and end at 08:02:30.

When the CSV Timepoint file is imported, the *Timepoint Window Navigator* tab is accordingly updated with the loaded timepoint windows.

Here an example of the three above absolute times with a window size of 3 minutes, loaded with the CSV Timepoint file.



In addition, it is possible to set an observation window that will be entered prior to each timepoint window. The length of the observation windows must be entered by either typing the value directly using the keyboard or by clicking the up/down arrows with the mouse.



3.19.2. Analysis Windows

By clicking the 'Load Analysis Windows' menu entry, a new dialog box (Figure 100) is displayed that allows the user to select the folder containing the annotated analysis Windows (AWs). The files in the selected folder must be in aECG FDA HL7 XML v. 1 format.

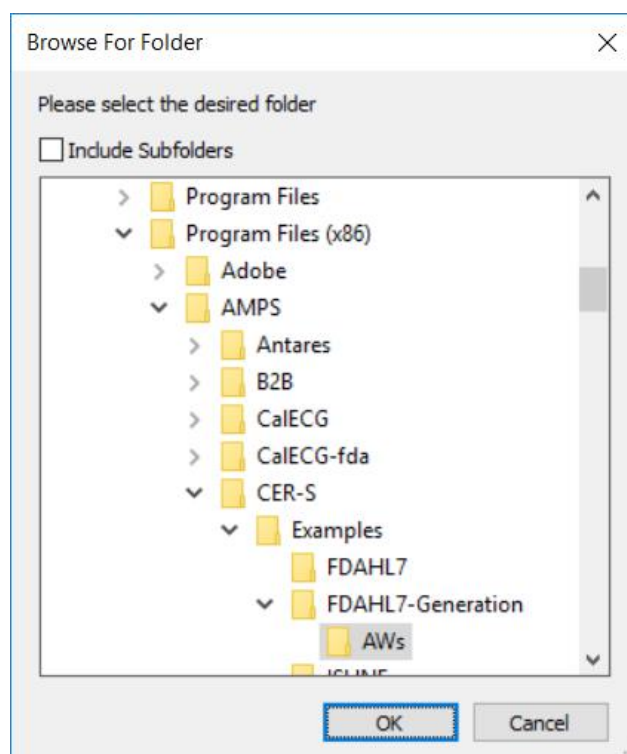


Figure 102 – AWs folder selection

All AWs that have the same Subject ID as the currently loaded continuous ECG and whose datetime of recording is within the start-end time of the currently loaded continuous ECG, will be automatically loaded.

There are situations where this automatic loading will not be computed. This can be due to various situations, the most frequent one being the scenario where AWs were not created using AMPS Antares technology and thus ECG were filtered or were time shifted (by less than a whole second).

In these cases, it is possible to load the AW by modifying the "aECGModule.ini" file stored in the folder storing CER-S settings. Refer to Section 3.3 of the System Manual for details.

Contact support@amps-llc.com to have a complete explanation of the two available options:

- CheckThreshold:** The value entered allows a threshold to be applied to the sample comparison. To compare the samples, the algorithm is designed to compare the difference between samples against the Threshold entered. Only if all the differences between (AW and CER) samples are below the threshold, the AW qualifies. This check is applied together with the time-shift. Thus the AW will be loaded, time-shifted by the number of millisecond (< 1000), having all the sample-differences below Threshold and minimizing the RMS. It must be an integer number representing the value in uV (microVolts).
- UseMinRMS:** Enabling this feature allows to load the AW, time-shifted by the number of milliseconds (< 1000) minimizing the RMS. Zero means OFF, 1 (or any other number) means ON

An AW whose datetime of recording falls within a loaded Timepoint, Window's start-end time will be visualized in the Timepoint Navigator as a child node of the timepoint Window.

AWs whose datetime of recording do **not** fall within any of the preloaded timepoint windows, will be visualized as newly created timepoint Windows (whose duration matches the AW's duration) that contain a reference to the AW.

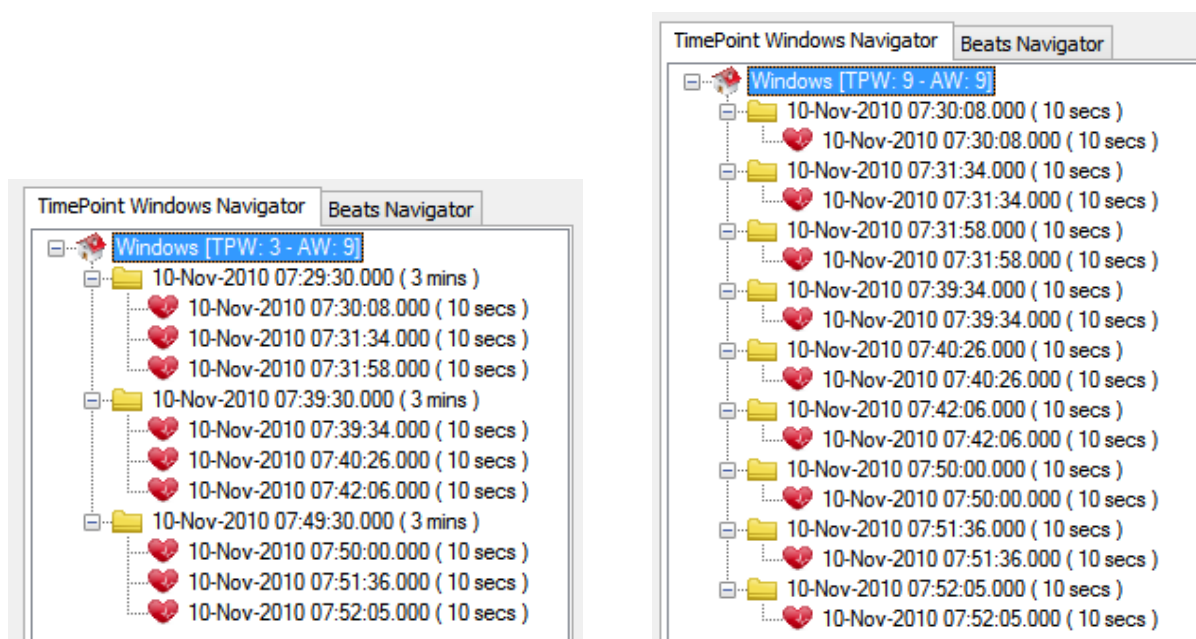


Figure 103 – Nine AWs loaded in the Timepoint Window Navigator.
First: AWs correctly loaded in the 3 TPWs, Second: AWs loaded with no TPWs

Even when no Timepoint Windows have been pre-loaded, Analysis Windows will be loaded in CER-S and a Timepoint Window will be automatically created with the very same time and duration of each AW.

3.19.3. Protocol Events

By clicking the 'Load Protocol Events' menu entry, a new dialog box (Figure 104) is loaded where the location of the CSV Protocol Events file may be specified.

Protocol Events must be loaded after Timepoint Windows, as the importation of Timepoint Windows will reset the loaded data.

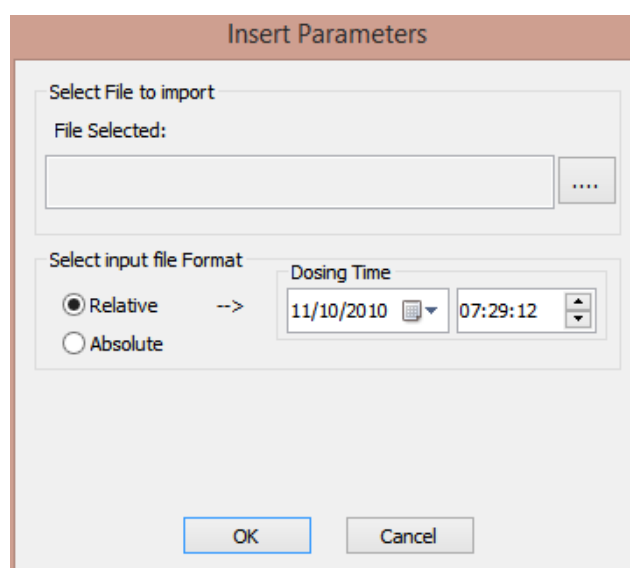
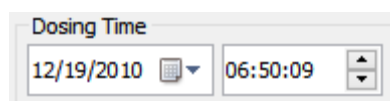


Figure 104 – Protocol Events settings dialog

CER-S supports two CSV Protocol Events formats:

- **Relative Timepoints:** In this format, timepoints are expressed as time and can be either positive or negative. In this case an additional parameter is required: the dosing time that all relative timepoints refer to.
Dosing time is set by default to the start time of the continuous ECG record and can be edited by either typing the value directly with the keyboard or by clicking the up/down arrows with the mouse.



Given below an example of 4 protocol events in relative time reporting Plasma Concentration 1 hour prior to dosing, at the dosing time, 1 hour after dosing and 5 hours post-dose, respectively.

```
-01:00:00;PlasmaConc 0
00:00:00;PlasmaConc 0
01:00:00;PlasmaConc 32
05:00:00;PlasmaConc 12
```

- **Absolute Timepoints:** In this format, timepoints are expressed in time/date format (separated by the semicolon ";" character) and no dosing time is required.

Here is an example of 3 protocol events in absolute time

```
08:00:00;19/10/2010;PlasmaConc 0
09:50:00;19/10/2010;PlasmaConc 22
11:49:00;19/10/2010;PlasmaConc 8
```

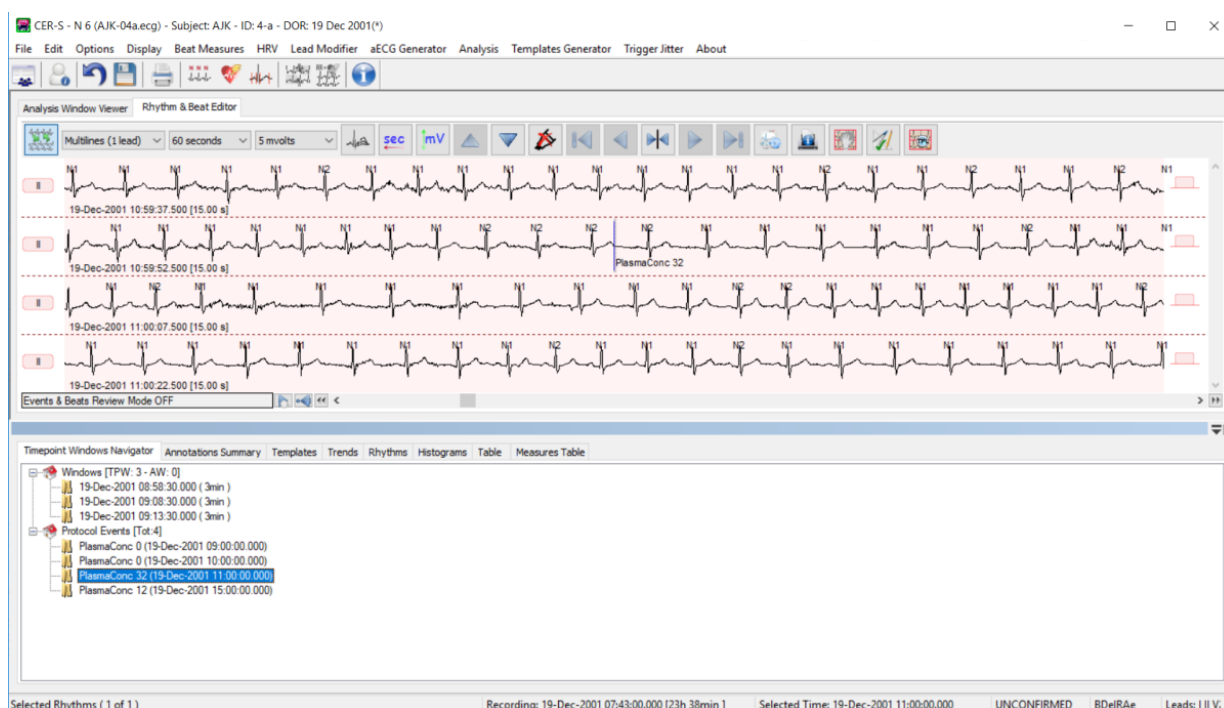


Figure 105 – Protocol Events Navigation

3.19.4. Annotation Removal

Using the "Remove annotations outside TimePoint Windows" entry from the "aECG Generator", it is possible to remove all ECG beat annotations that are not included in the loaded Timepoint Windows.

In this case, beat annotation editing can be limited to the annotations that will affect subsequent ECG extractions.

It is also possible in addition to maintain the annotations within the observation window selecting "Remove annotations outside TimePoint Windows (except Observation Window)".

3.19.5. aECG Exportation

Once the components are loaded (at minimum one AW), it is possible to generate a continuous ECG recording in the aECG FDA HL7 XML version 2 format by clicking on the last entry from the "aECG Generator" menu: "Export aECG FDA HL7 record".

A new dialog box prompts the user to select the output folder name. Output data will be saved with the same filename as the input continuous ECG recording.

3.20. Analysis Menu

Depending on the licensed version, the software allows to perform different analyses on the loaded Continuous ECG Recording, namely Beat Detection, Rhythm analysis and Multiday Analysis, using ABILE algorithm.

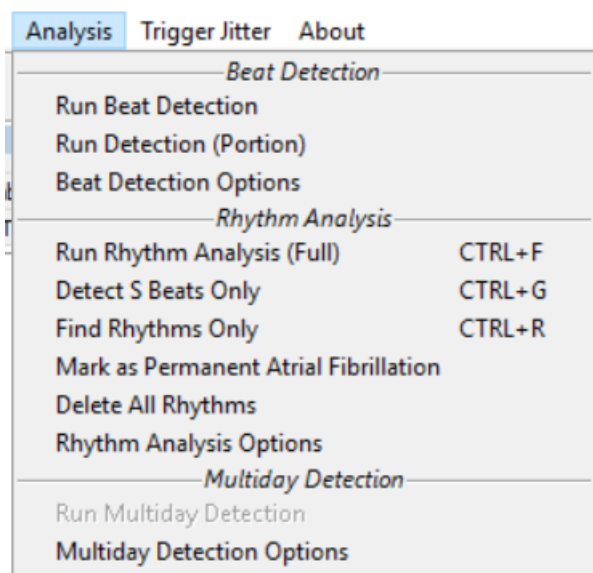



Figure 106 – Analysis menu

3.20.1. Beat Detection

To perform ECG beat detection and beat classification, select "Run Beat Detection" from the "Analysis" Menu (see Figure 106) or clicking the "Run Beat Detection" toolbar button .

Note that the "Beat Detection" process also generates the ECG Templates whose display is described in section 3.13.

Note that beat detection and automatic template identification is only related to the QRS complex, P and ST complexes are not used.

Beat Detection can only be performed on Continuous ECG Recording with a maximum length of 4 days.

In case ECG annotations are present, before the Beat Detection is performed, a dialog appears informing the user that this operation will reset all annotations, as shown below.

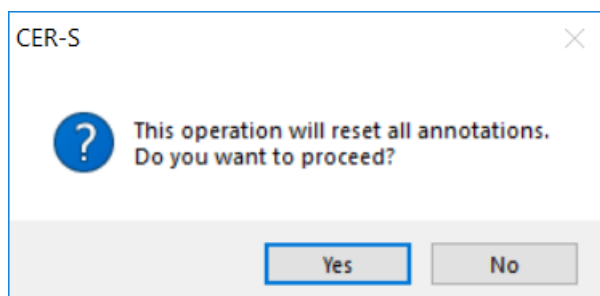
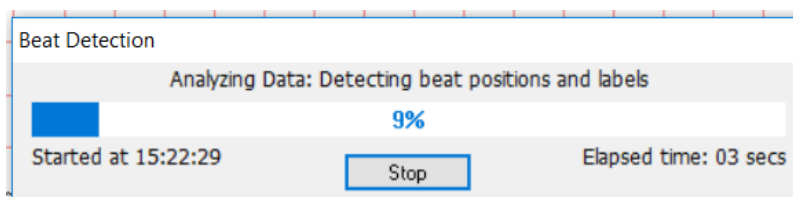


Figure 107 – Dialog box informing that the Beat Detection will reset all annotations

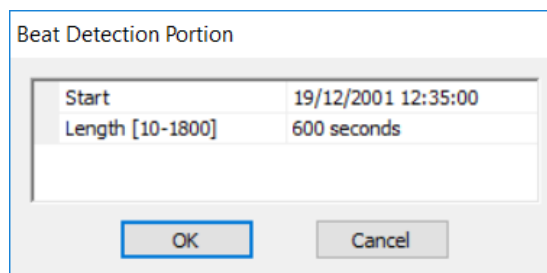
The time needed for the Beat Detection depends on the recording length, and the following display informs the user of the elapsed time and processed percentage.



In case it is needed, Beat Detection process can be aborted, in which case the status of the recording will be set to "BDs", indicating that Beat Detection process has been stopped.

From the same Analysis menu, it is possible to perform ECG detection on a small portion of the continuous ECG recording, selecting "Run Detection (Portion)".

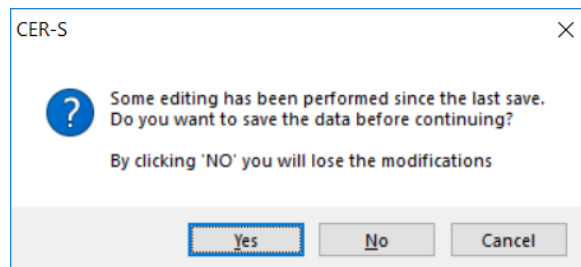
Then, the starting position and the length of the ECG portion to be processed, up to a maximum of 30 minutes (1800 seconds), must be selected.



When beat detection is performed, the change of status is reported in CER-S status bar as "BD", while if detection is stopped, status will be set to "BDs". In case modifications are

made by the user the new status is reported in CER-S status bar "BDe", refer to section 3.3.3 for all the details on Analysis status.

If manual modifications are made and not yet saved in the ACEA session file, a visual alert '*' is displayed on the title bar and if the user attempts to close the software or load a new record, the following warning message is prompted:



3.20.1.1. Beat Detection Options

Selecting "Detection Options" from Analysis menu (Figure 106), a new dialog box is displayed (Figure 108) listing the "Beat Detection settings currently used", and allowing to edit the default "Beat Detection settings" saved from the last analysis and restored from the "AnalysisModuleOptions.ini" file available in the folder storing CER-S settings. Refer to Section 3.3 of the System Manual for details.

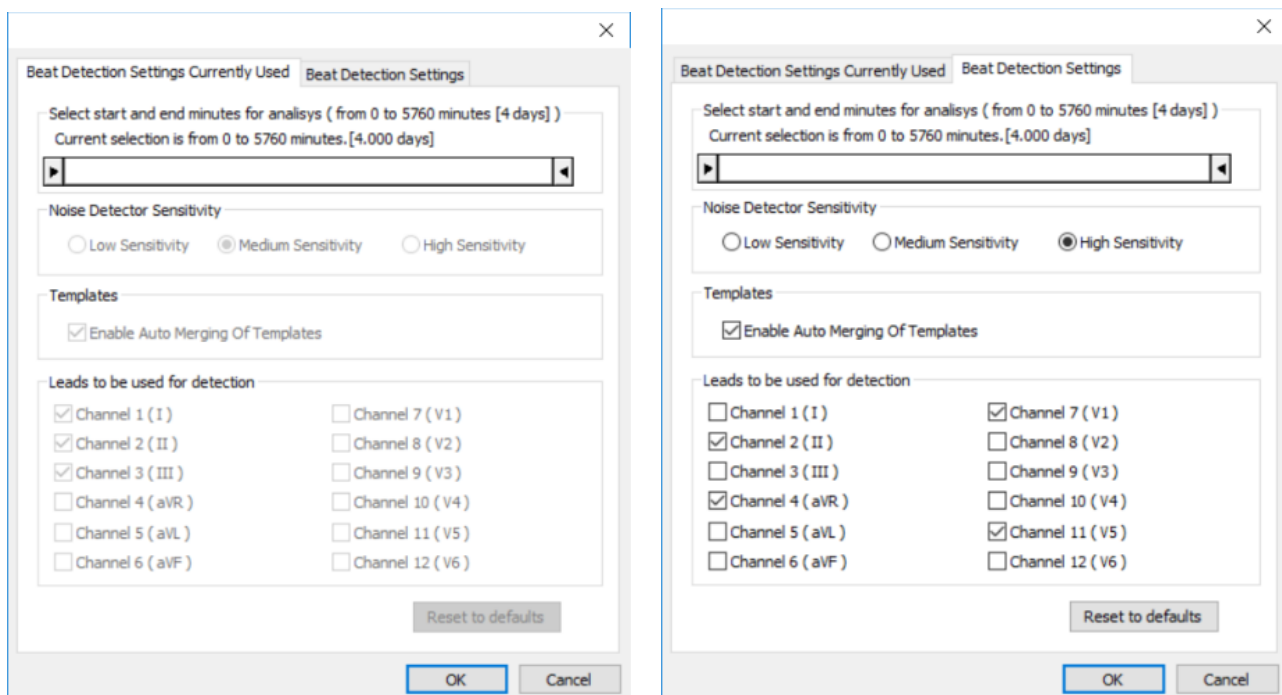


Figure 108 – "Detection Options" dialog. The "Beat Detection settings currently used" tab is shown on the left and the default "Beat Detection settings" shown on the right.

The "Beat Detection settings" tab lets the user:

- specify the effective length of the rhythm data that will be used by ABILE algorithm to compute the beat detection. The default selection is from 0 to 4 days (5760 minutes).

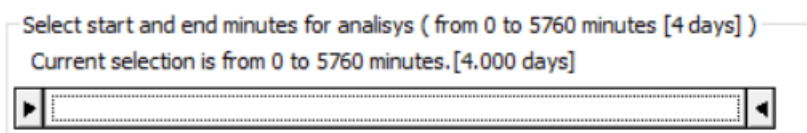


Figure 109 – Default rhythm data length used by ABILE algorithm

- select the sensitivity of the noise detection algorithm between:
 - Low sensitivity
 - Medium sensitivity
 - High sensitivity – default
- enable/disable the auto-merging of the templates
- select the leads that the ABILE algorithm will use to perform the beat detection. The maximum number of leads to be used is 8.

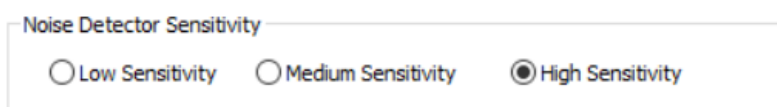



Figure 110 – Noise Detector Sensitivity selection

3.20.2. Rhythm Analysis

To perform Rhythm Analysis, select "Run Analysis (Full)" from the "Analysis" Menu (Figure 111) or clicking the  toolbar button.

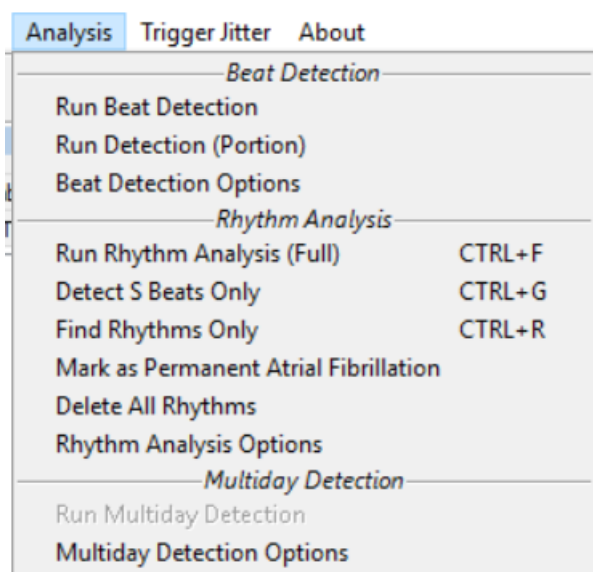


Figure 111 – "Run Analysis" entry of the Analysis menu

Rhythm Analysis can only be performed on Continuous ECG Recording with a maximum length of 4 days.

The (Full) analysis is composed in two steps:

- Supraventricular beats detection
- Rhythms detection


It is possible to perform the sole S beats detection, via the "Detect S Beats Only" menu entry, or to perform the sole rhythms detection, via "Find Rhythms Only" menu entry.

The rhythm annotations that can be detected automatically are listed below:

- Atrial Fibrillation
- Bradycardia
- Pause
- Prolonged RR Interval
- Supraventricular Tachycardia
- Isolated Supraventricular Beat
- Supraventricular Couplet
- Supraventricular Run
- Supraventricular Bigeminy
- Supraventricular Trigeminy
- Ventricular Tachycardia
- Isolated Ventricular Beat
- Ventricular Couplet
- Ventricular Run
- Ventricular Bigeminy
- Ventricular Trigeminy

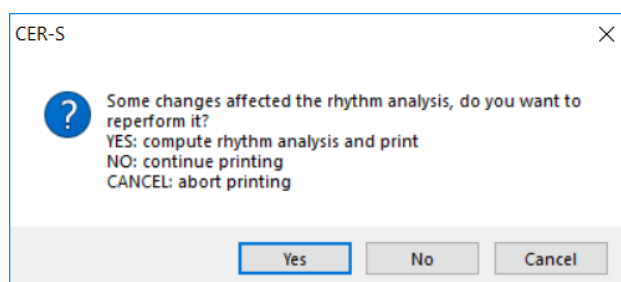
When running "Run Analysis (Full)" and "Find Rhythms Only", the automatic ECG strips are recomputed.

When rhythm analysis is performed, the change of status is reported in CER-S status bar as "RA". In case modifications are made by the user the new status is reported in CER-S status bar "RAe", in case a modification made by the user can alter the analysis results, a visual alert reporting that the analysis could be obsolete ("RA Obsolete") is displayed on the title bar and the new status is reported in CER-S status bar "RA(obs)", refer to section 3.3.3 for all the details on Analysis status.

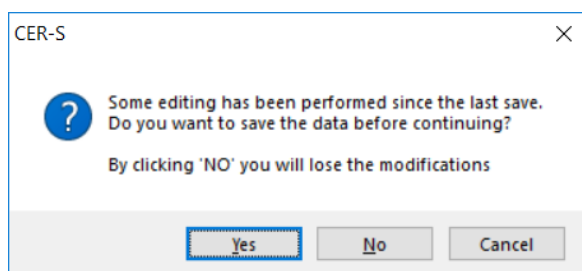
 CER-S - N 6 (AJK-04a.ecg) - Subject: AJK - ID: 4-a - DOR: 19 Dec 2001-(RA Obsolete)

When the analysis is obsolete, if the user proceeds in printing the report (see section 3.27), a message box is prompted informing the user that rhythm annotations are obsolete and providing three options:

- recompute rhythm analysis before printing the report – clicking YES
- proceed with printing the report, without recomputing rhythm analysis –NO
- cancel printing - CANCEL



If manual modifications are made and not yet saved in the ACEA session file, a visual alert '*' is displayed on the title bar and if the user attempts to close the software or load a new record, the following warning message is prompted:



3.20.2.1. Rhythm Analysis Options

Selecting "Analysis Options" from the Analysis menu (Figure 111), a new dialog box with two tabs (Figure 112) is displayed. This dialog box lists the "Rhythm Analysis settings currently used", allowing the user to edit the default "Rhythm Analysis settings" saved from the last analysis and restored from the "ArrhythmiaAnalysisModuleOptions.ini" file available in the folder storing CER-S settings. Refer to Section 3.3 of the System Manual for the details.

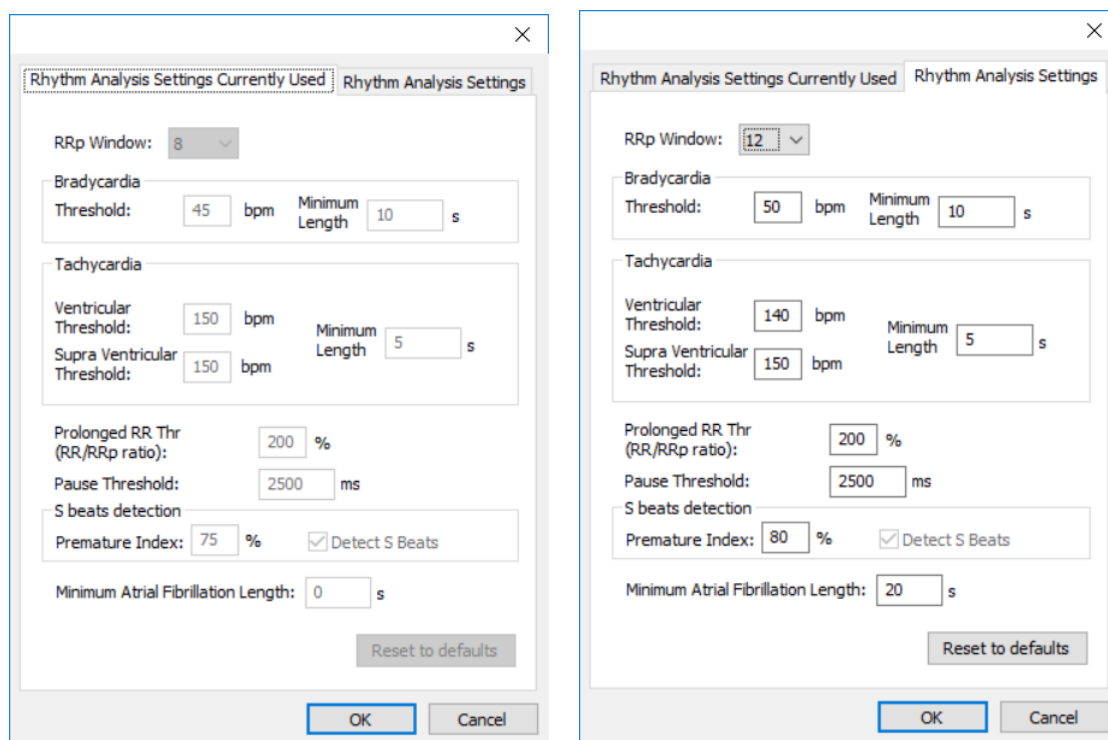


Figure 112 – "Rhythm Analysis Settings" dialog box: "Rhythm Analysis settings currently used" tab is shown on the left and the default "Rhythm Analysis settings" shown on the right.

Available Rhythm Analysis settings are:

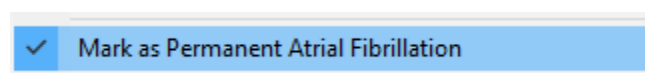
- Average RR (RRp) Window size: in this section, the user can select the number of beats that must be used to compute the RRp.
 - Available entries are 4, 8, 12 and 16, default being 8.

- Bradycardia: in this section, to annotate the rhythm as “Bradycardia”, the user can set the *threshold* in bpm and the *minimum length* of data in seconds.
 - Allowed values for *threshold* are between 1 and 90 bpm, 45 being the default.
 - Allowed values for *minimum length* are between 1 and 50 s, 10 s being the default.
- Tachycardia: in this section, to annotate the rhythm as “Tachycardia”, the user can set the *Ventricular* and *Supra Ventricular threshold* in bpm and the *minimum length* in seconds.
 - Allowed values for *threshold* are between 1 and 500 bpm, 150 being the default.
 - Allowed values for *minimum length* are between 1 and 50 s, 5 being the default.
- Prolonged RR threshold in percentage.
 - Allowed values are between 10 and 1,000 %, 200 being the default.
- Pause threshold in ms.
 - Allowed values are between 1,000 and 20,000 ms, 2,500 being the default.
- Prematurity index in percentage.
 - Allowed values are between 10 and 90 %, 70 being the default.
- Minimum AFIB length
 - Allowed values are between 0 and 3600 s (1 hour), 0 being the default.

If Beat editing is performed after Rhythm analysis has run, there could be erroneous Rhythm annotations still visualized.

3.20.2.2. Permanent Atrial Fibrillation

By selecting “Mark as Permanent Atrial Fibrillation” from the Rhythm menu, an Atrial Fibrillation rhythm annotation having the length of the entire record is added. Then, all S beats are marked as N and all S-related events are automatically removed.




Select the entry again to remove the status of permanent Atrial Fibrillation, in this case the related annotation is removed.

This entry is also available in case Multiday analysis has been performed.

3.20.3. Multiday Analysis

In case of long recording, the software can perform a simplified Beat Detection and Rhythm Analysis, named Multiday Detection which can be launched selecting “Run Multiday

Detection” entry from the “Analysis” Menu (Figure 113) or clicking the  toolbar button. This analysis is designed for the identification of episodes of Atrial Fibrillation, Ventricular Tachycardia and Pauses.

Multiday Detection can only be performed on Continuous ECG Recording with a length between 1 and 30 days.

The Beat detection component will detect the ECG beats, but at the end on analysis beat information and beat navigation will not be available and similarly Templates will not be computed.

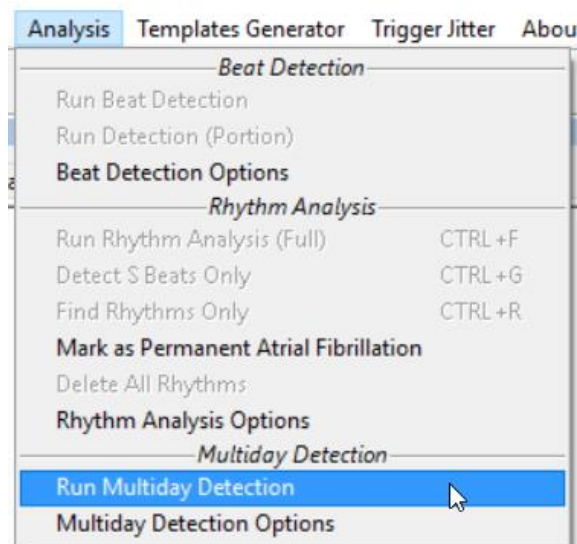
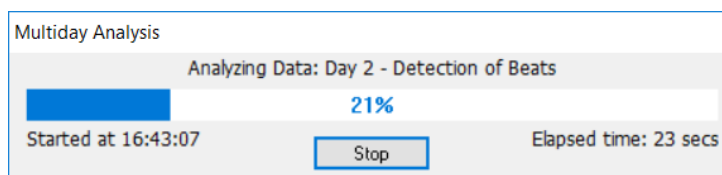


Figure 113 – "Run Multiday Analysis" entry of the Analysis menu

The rhythm annotations that can be here detected automatically are:

- Atrial Fibrillation
- Pause
- Ventricular Tachycardia

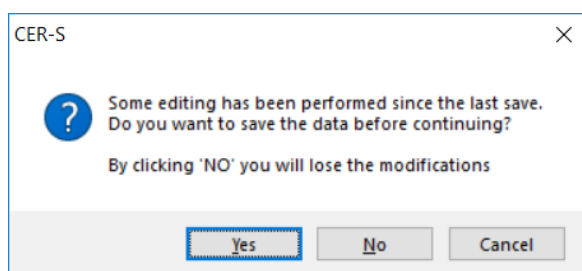
The time needed for the Multiday Detection depends on the recording length, and the following display informs the user of the elapsed time and processed percentage.



In case it is needed, Multiday Detection process can be aborted, in which case the status of the recording will be set to "MDs", indicating that Multiday Detection process has been stopped.

When multiday analysis is performed, the change of status is reported in CER-S status bar as "MD". In case modifications are made by the user the new status is reported in CER-S status bar "MDe".

If manual modifications are made and not yet saved in the ACEA session file, a visual alert '*' is displayed on the title bar and if the user attempts to close the software or load a new record, the following warning message is prompted:



In case of multiday recordings it is possible to select detailed analysis segments to cut and export and subsequently to perform standard Beat Detection and Rhythm analysis and that segment in a new CER-S session.

The maximum length of a detailed analysis segment is 24 hours. Refer to section 3.7.5 for more details.

When running "Multiday Detection", the automatic ECG strips are recomputed.

In case of Multiday analysis, automatic ECG strips are not identified when running "Multiday Detection", but at the time of printing the report.

3.20.3.1. Multiday Analysis Options

Selecting "Multiday Detection Options" from the Analysis menu (Figure 113), a new dialog box with four tabs (Figure 114) is displayed. This dialog box lists the "Beat Detection settings currently used" allowing to edit the default "Beat Detection settings" and the "Rhythm Analysis settings currently used" allowing to edit the default "Rhythm Analysis settings" saved from the last analysis and restored from the "LongAnalysisModuleOptions.ini" file available in the folder storing CER-S settings. Refer to Section 3.3 of the System Manual for the details.

Available Beat Detection settings are:

- select the sensitivity of the noise detection algorithm between:
 - Low sensitivity
 - Medium sensitivity
 - High sensitivity – default
- select the leads that the ABILE algorithm will use to perform the beat detection. The maximum number of leads to be used is 8.

Available Rhythm Analysis settings are:

- Ventricular Tachycardia
 - Allowed values for *threshold* are between 1 and 500 bpm, 150 being the default.
 - Allowed values for *minimum length* are between 1 and 50 s, 5 being the default.
- Pause threshold with values are between 1'000 and 20'000 ms, 2'500 being the default.
- Minimum AFIB length with values are between 0 and 3600 s (1 hour), 0 being the default.

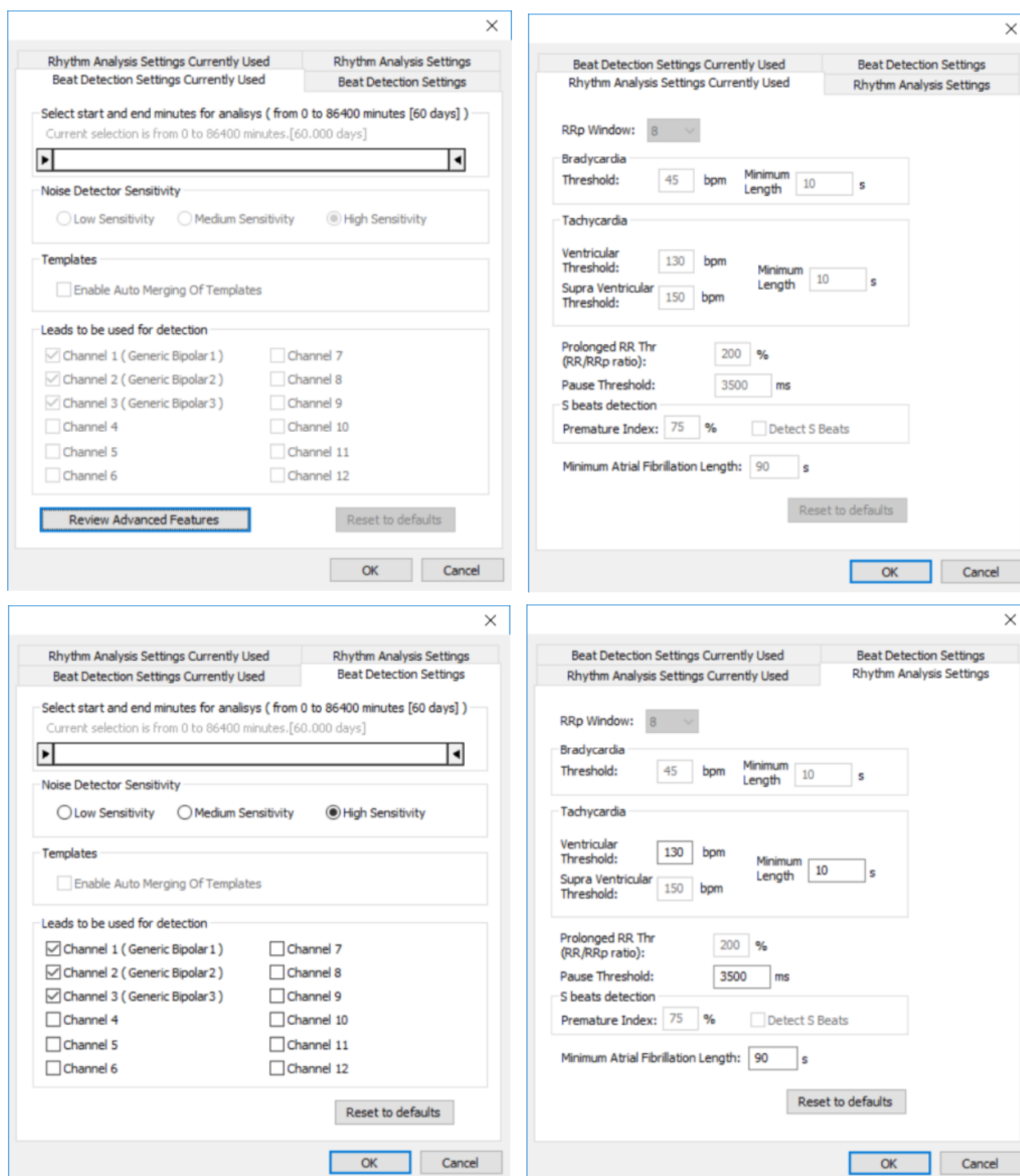


Figure 114 – "Multiday Detection Settings" dialog box: "Beat Detection settings currently used" and "Rhythm Analysis settings currently used" tabs are shown on the top row, left and right respectively; "Beat Detection settings" and "Rhythm Analysis settings" tabs are shown on the lower row, left and right respectively.

3.21. Beat Measures Menu

The software allows to perform automatic measures using BRAVO algorithm.

To perform the analysis, select "Run Beat Measures" from the "Beat Measures" menu (see Figure 115).

Beat Measure can only be performed on Continuous ECG Recording with a maximum length of 2 days.

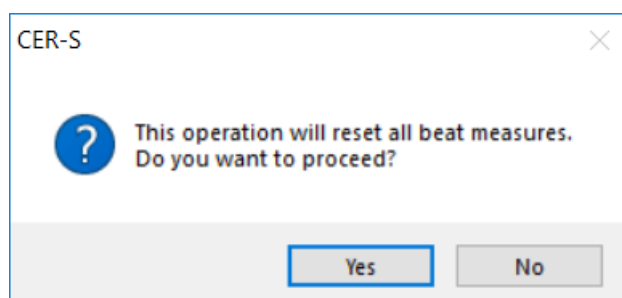
The measures can be computed on beats' family, where each family is a group of contiguous beats belonging to the same time-bin.

The dimension of the time-bin and the settings can be configured in the options dialog described in section 3.21.1.

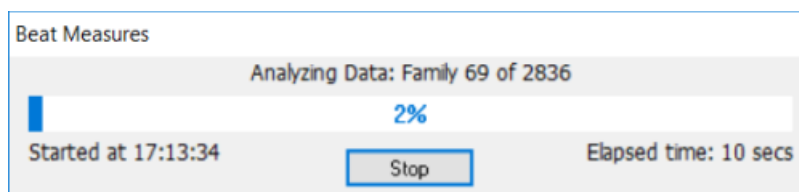


Figure 115 – Beat Measures menu

In case the beats' measures are already present, a dialog box informing the user that the operation will delete all the existing measures, is displayed.



The time needed for the Beat measurements depends on the recording length and the number of leads to be measured, and the following display informs the user of the elapsed time and processed percentage.

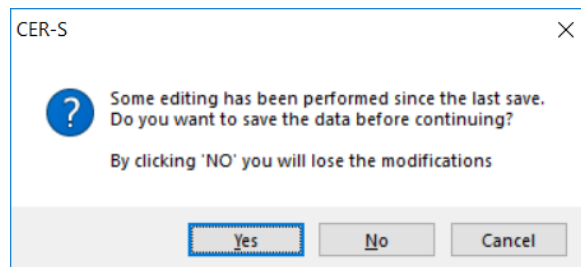


In case it is needed, Beat Measure process can be aborted, in which case the status of the recording will be set to "B2Bs", indicating the process has been stopped.

The computed measures can be reviewed and edited in the graphical pages (Trends, Histogram, Table and Measures Table).

When Beat Measure is performed, the change of status is reported in CER-S status bar as "B2B". In case modifications are made by the user the new status is reported in CER-S status bar "B2Be".

If manual modifications are made and not yet saved in the ACEA session file, a visual alert '*' is displayed on the title bar and if the user attempts to close the software or load a new record, the following warning message is prompted:



In the 'Beat Measures' menu, the following entries are available:

- Beat Measures Options: review and change the analysis options. Refer to section 3.21.1 for details.
- Select Unmeasured Families: select this entry to review the beats family having any missing measure. See section 3.21.2 for details.
- Delete All Measures: delete a previously performed analysis. All beat measures and families will be deleted.
- Review Families: review all measured families, see section 3.21.3.
- Export Measures: export all the computed measures in csv file format. Refer to section 3.16.1 for details.

3.21.1. Beat Measures Options

Selecting "Beat Measures Options" from the Beat Measures menu (Figure 115), a new dialog with two tabs is displayed (Figure 116). The dialog lists the "Beats Measure settings currently used" and allows the user to edit the default "Beats Measure settings", saved from the last analysis and loaded from the "BeatToBeatModuleOptions.ini" file available in the folder storing CER-S settings. Refer to Section 3.3 of the System Manual for the details.

Available Beats Measure settings are:

- Leads to be measured: in this section the user can select the leads to be measured with BRAVO algorithm.
- Vector Magnitude (VM): here the user can decide if the Vector Magnitude (VM) shall be measured and, in such case, if it shall be computed with all available leads or with the above selected subset.
- Beats to be measured: the size of the window where ECG beats will be grouped and averaged.
Beats are grouped in time-bin families, the bin's dimension is configurable between 30 and 300 seconds (5 minutes) and the default value is 30 seconds. For each family, a representative beat is created and measured.

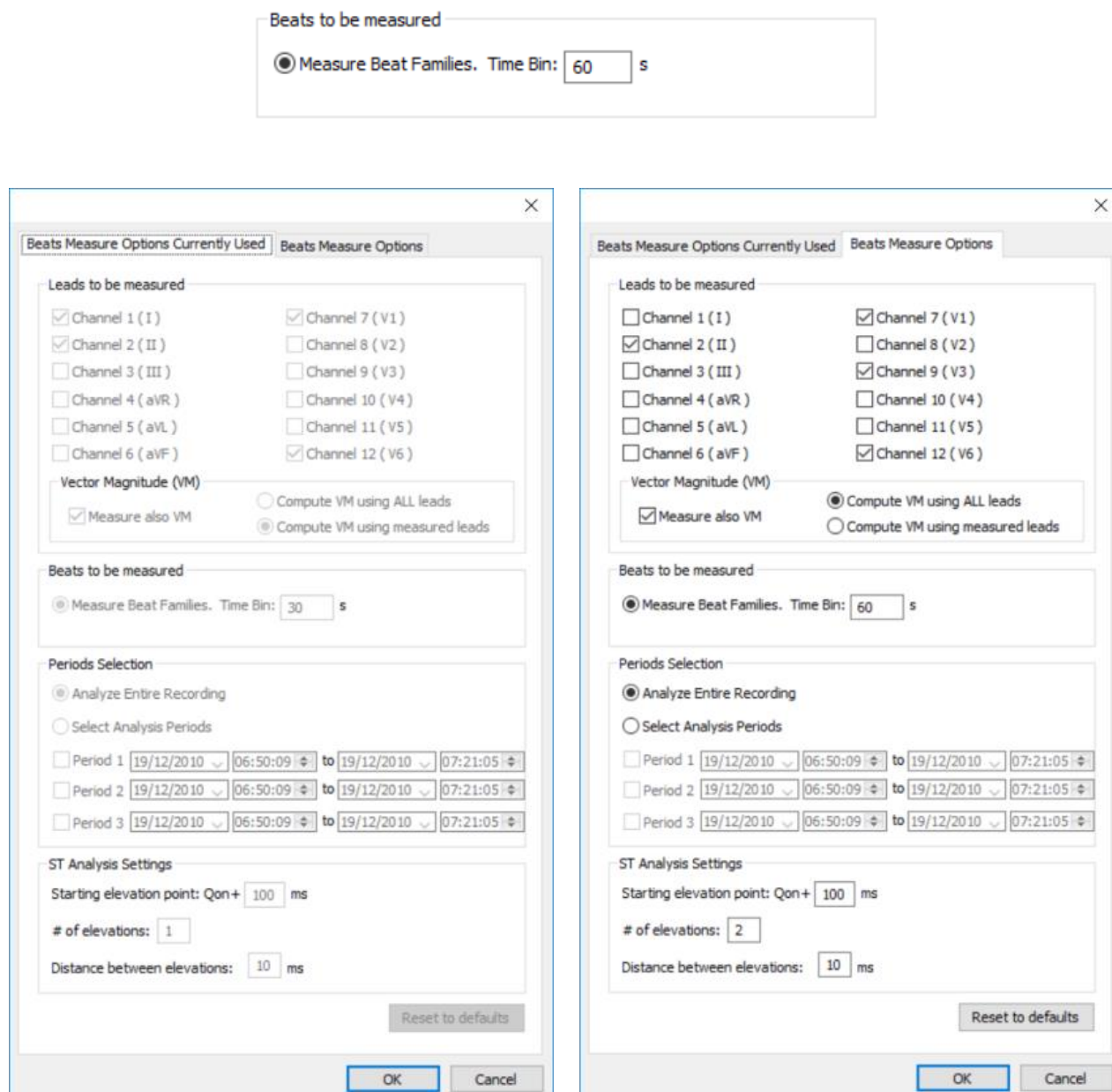
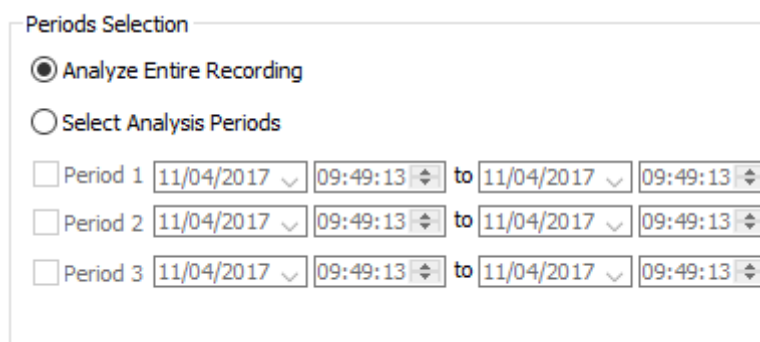


Figure 116 – "Beats Measure Settings" dialog: "Beats Measure settings currently used" tab is shown on the left and the default "Beats Measure settings" tab is shown on the right.

- **Periods Selection:** it is possible to analyze the entire recording or select up to three periods of analysis. The three periods are independent and can be overlapped.



- **ST Analysis Settings:** the application provides an analysis of the ST segment. it is possible to set:
 - The ST elevation point (in ms after the Qon, accepted values between 0 and 300 ms, default being 80 ms).
 - The number of the elevation points (accepted values between 1 and 20, default being 1).
 - The distance between the elevation points (valid only in case of # of elevation points greater than 1, accepted values between 1 and 20, default being 10 ms).

In case the number of elevation points is greater than 1, the area and the slope of the ST segment are also computed.

ST Analysis Settings

Starting elevation point: Qon+ 80 ms

of elevations: 1

Distance between elevations: 10 ms

3.21.2. Review Unmeasured Families

To review the families having any missing measures, select the "Review Unmeasured Families" entry of the Beat Measures menu.

Selecting the entry, a new dialog box is displayed where it is possible to filter the unmeasured families (Figure 117).

It is possible to select the missing calipers to search. The calipers that can be selected are: Pon, Poff, Qon, Qoff, Soff, Toff, Tmax and Isoelectric. All the families having any of the selected calipers missing will be reviewed.

Select Unmeasured Families

Select families having missing:

- ☒ P onset
- ☒ P offset
- ☒ Q onset
- ☒ S offset
- ☒ T offset
- ☒ T Max
- ☒ Isoelectric

Lead: I

Period: Period1

OK Cancel

Figure 117 – Select Unmeasured Families dialog

It is possible to change the lead and the period to select unmeasured families. The period menu is available only in case of multiple-period analysis.

Pressing the OK button, the 'Adjust Measures' dialog box is shown and the selected unmeasured families can be reviewed and manually measured (refer to section 3.21.3 below).

3.21.3. Adjust Measures Dialog

The measured families can be reviewed in the 'Adjust Measures dialog' (Figure 119 – Adjust Measure dialog).

This dialog is used to review a selection of families. The representative beat of the current family along with its calipers is displayed.

On the right of the ECG signal are reported the family's measures of the displayed lead(s) (Figure 118): PR, QRS, JT, QTp, TpTe, JTp, Pdur, Tamp, ATcB, QTcF, ST Analysis Data (ST Elevation(s), ST Area and ST Slope), T Wave Parameters (T Area, T Symmetry and T Wave times).

Information about the currently displayed family are available in the bottom of the dialog.

Current Family 2 of 7 - Bin Start Time: 2011-Mar-16 07:13:13, Bin Duration: 120 s, Nr of beats: 122, RR: 979 ms	
Derived (V5)	
PR	169 ms
QRS	88 ms
QT	382 ms
JT	294 ms
QTp	304 ms
TpTe	78 ms
JTp	216 ms
Pdur	110 ms
Tamp	395 uV
QTcB	389 ms
QTcF	387 ms
ST Elev. Qon+100	53 uV
T Area	49342 uV*ms
T SymArea	41 %
t25	145 ms
t50	194 ms
t75	226 ms
t97	273 ms
t25_75	81 ms
t20_80	104 ms
t25_50	49 ms
t50_75	32 ms
t75_97	47 ms

Figure 118 – Measures Panel of the Adjust Measures dialog

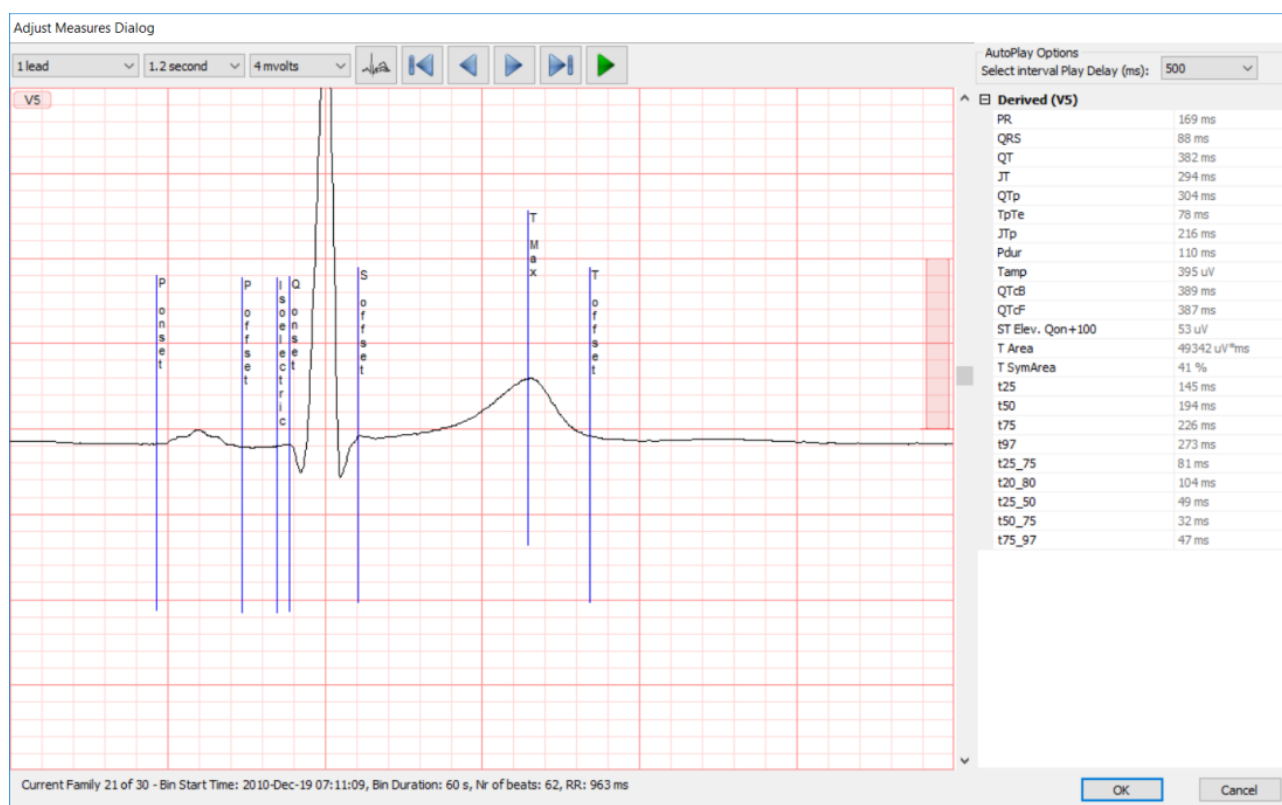


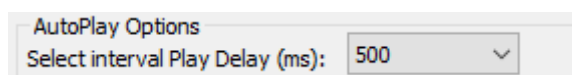
Figure 119 – Adjust Measure dialog

3.21.3.1. Navigation

When multiple families are selected via one of the available “navigation” modules (Histograms, Tables or Trends) or by one of the following entries of the Beat Measures menu (“Review Unmeasured Families” or “Review Families”) in the *Adjust Measures Dialog*, it is possible to navigate within the selection. Namely it is possible to display the previous/next or first/last item via dedicated toolbar buttons. It is also possible to auto-play the navigation.



In case of auto-play (the green arrow button), it is possible to select the time (in milliseconds) which must elapse between a family and the next using the menu above the measures panel.



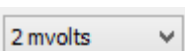
3.21.3.2. Lead Display Customization



The number of leads to display can be configured by selecting the appropriate entry from the leftmost drop-down menu.

The displayed time is fixed to 1.2 seconds.

3.21.3.2.1. Voltage Display Customization



The amplitude resolution to display can be configured by selecting the desired resolution from the third drop-down menu from the left.

Available voltage resolutions are between 1 and 8 mV.

3.21.3.2.2. Superimposition Display



Standard/superimposed ECG waveform display can be toggled using the first toolbar button from the left.

Here below in Figure 120 is an example of Superimposed ECG waveforms.

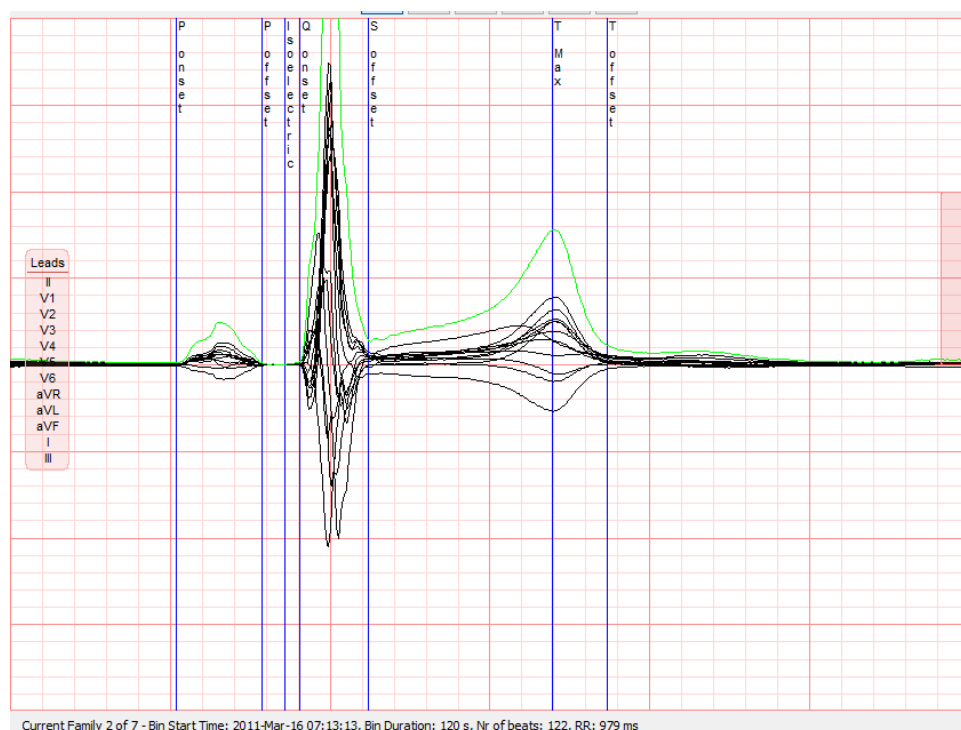


Figure 120 – Superimposed mode in the Adjust Measures dialog. The calipers are related to the VM, which is displayed with a green line.

In case of superimposed mode, the displayed calipers are related to the VM and the reported measures in the panel on the right are the global measures.

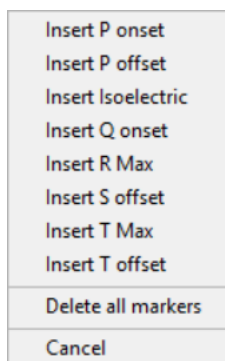
3.21.3.2.3. Measures Editing

If the *Rhythm and Beat Editor* is active and the modifications are allowed, in the *Adjust Measures* dialog it is possible to manually adjust, add or remove the calipers.

To select a caliper, click with the primary mouse button on it. Once a caliper has been selected, the left or right arrows keys (or the related shortcut keys) can be used to adjust its position, moving the caliper sample by sample, but it is also possible to adjust measure position, moving 10 samples at a time.

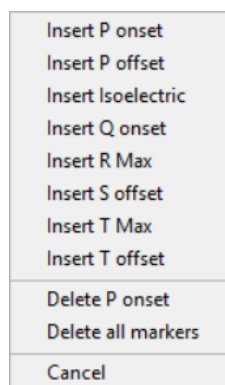
Caliper editing can also be performed via drag and drop with the primary mouse button.

Clicking the secondary mouse button, a context menu composed of a list of the calipers is displayed.

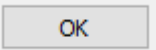
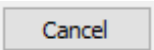


Selecting one of the listed calipers, it is possible to change its position (if it is already present) or add a new caliper (if the selected one is not present).

If the click is on an existing caliper, an entry aimed at deleting the selected caliper is added to the list.



The measures displayed in the right panel will be real-time update for each caliper modification (correction, addition or removal).

To close the *Adjust Measures Dialog*, click on  or on  buttons. In the first case all the modifications will be saved, otherwise they will be lost.

3.22. Templates Generator Menu

The software allows the users to generate templates starting from the already existing beat annotations using ABILE algorithm. To perform the analysis, select "Generate Templates" from the "Templates Generator" Menu (Figure 121).

The generated templates can be reviewed in the display described in section 3.13.

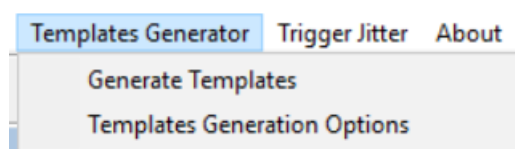
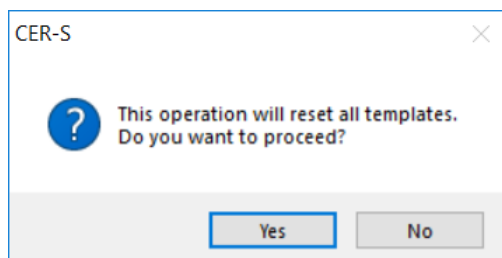
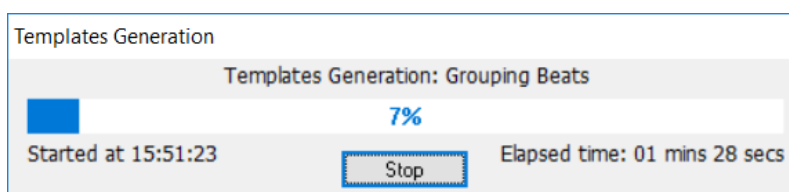


Figure 121 – Templates Generator menu

In case templates are present, a dialog appears informing the user that this operation will reset all templates, as shown below:



The time needed for the Templates Generation depending on the recording length, the following dialog informs the user about the elapsed time and allows to end the process.



In case it is needed, Templates Generation process can be aborted by clicking the Stop button.

3.22.1. Templates Generator Options

Selecting "Templates Generation Options" from the Templates Generator menu (Figure 121), a new dialog with two tabs is displayed (Figure 122). This dialog lists the "Rhythm Analysis settings currently used" and allows editing of the default "Rhythm Analysis settings" saved from the last analysis and restored from the "AnalysisModuleOptions.ini" file available in the folder storing CER-S settings. Refer to Section 3.3 of the System Manual for the details.

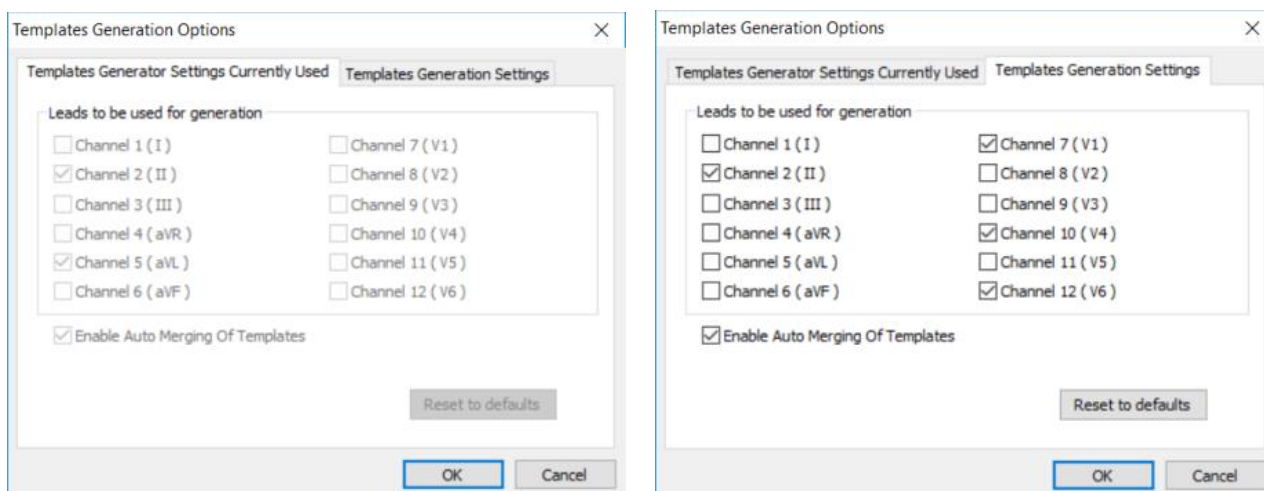


Figure 122 – "Templates Generator Settings" dialog. "Templates Generator settings currently used" tab is shown on the left and the default "Rhythm Analysis settings" is shown on the right.

The Templates Generator Settings tab lets the user select the leads that the ABILE algorithm will use to generate the templates.

It is also possible to enable the auto merging of templates at the end of the generation.

3.23. Trigger Jitter Menu

The software allows to adjust the beats' position, centering it on the R peak, from the "Trigger Jitter" Menu (see Figure 123).

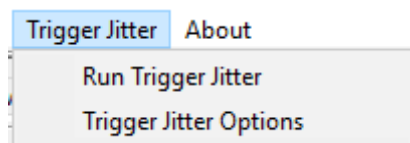
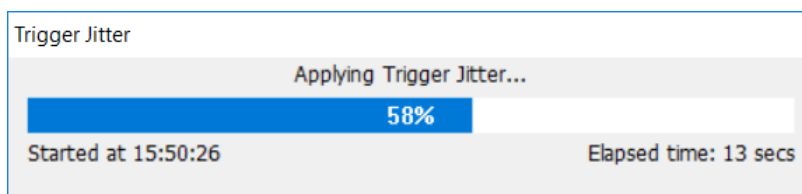


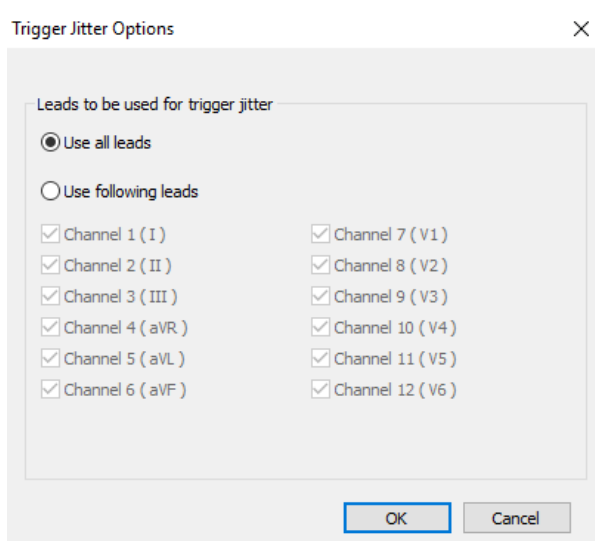
Figure 123 – Trigger Jitter menu

The time needed for the Trigger Jitter depends on the recording length. The following dialog informs the user of the elapsed time.



3.23.1. Trigger Jitter Options

Upon selecting "Trigger Jitter Options" from the Trigger Jitter menu, the following dialog is displayed:




From the options dialog, it is possible to select the leads to be used for the trigger jitter.

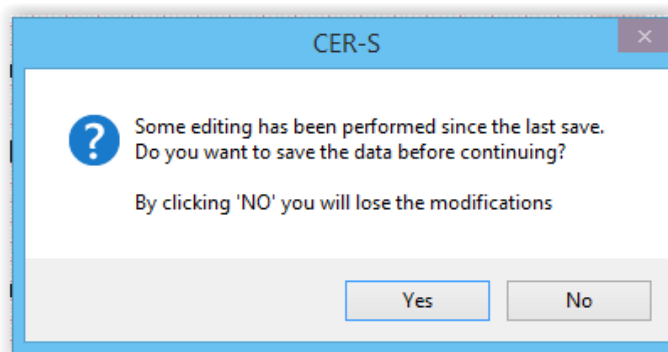
3.24. Session saving

In case Beat Detection/Editing, Arrhythmia analysis/editing or Beat Measure analysis/editing has been performed, it is possible to save the current state in "ACEA" binary session file that will be outputted in the same folder as the Continuous ECG recording.

The session file will be automatically restored when the recording is loaded.

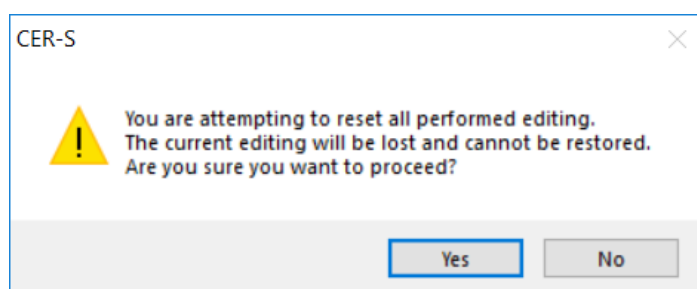
To save the current session, select "Save Session" entry from "File" menu, click on  button or use the related shortcut key.

Note that if any change has been made, upon closing the software, the user will be prompted to save the modifications as shown below:



3.25. Reset Editing

To reset all performed editing, from "File" menu select the "Reset Editing" entry. A message box alerting the user that the operation is unrecoverable is shown.



By pressing OK all the performed modifications will be lost.

3.26. Continuous ECG exportation

When a Continuous ECG recording has been loaded in the software, it can be exported in various formats, depending on the available plugin provided with the installation (contact support@amps-llc.com to have the list of available output formats), by selecting the Filed -> Export Record entry from File menu.

The "Save As" dialog will be prompted, where the user will select the location to export the data and the export format.

There are two main export features, one that allows the exportation of the Continuous ECG recording in a different format and the exportation of the sole results of the analyses, typically in ACEA XML, briefly described in 3.26.4 and more deeply in section 3.5 of the System Manual.

The main formats for the exportation of the Continuous ECG recording are "ISHNE", "MIT (WFDB)" and AMPS compressed format (ACecg), the format use for exportation of detailed analysis segments. In case of the former export format it is possible to select to export:

- ISHNE waveforms and annotations (in TXT format)
- ISHNE waveforms only
- ISHNE annotations (in TXT format)
- ISHNE annotations (in ANN binary format)
- ISHNE annotations (in CEBA binary format)

3.26.1. Resampling

When exporting a Continuous ECG recording, it may be useful to change the sampling-rate by over-sampling or down-sampling. This can be performed by modifying, in the "Save As" dialog, the desired output sampling-rate. By default, this is set as an input value, however the user can instead choose to enter a desired value in the range of 50-1000 Hz.

3.26.2. Rescaling

When exporting a Continuous ECG recording, it may be useful to change the amplitude resolution. This can be performed by modifying the desired output amplitude scale in the "Save As" dialog. By default, this is set as an input value, but the user can choose to instead enter a desired value in the range of 40-1000 count/mV.

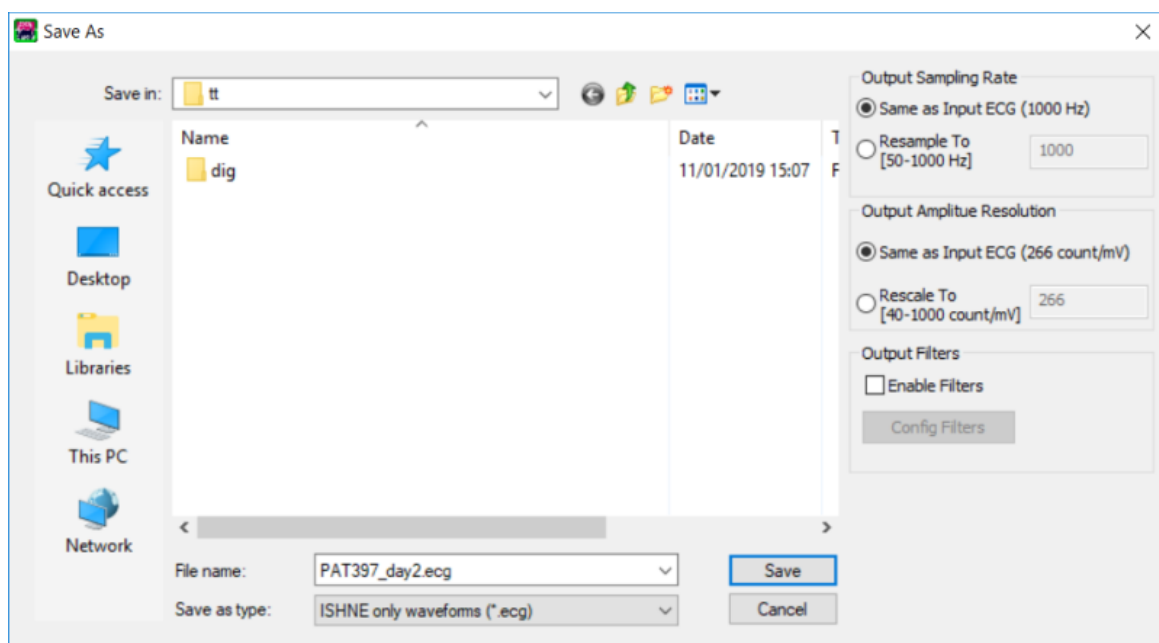


Figure 124 – Save As dialog, possibility to modify output sampling-rate and amplitude resolution

3.26.3. Filtering

When exporting a Continuous ECG recording, it is possible to apply digital filters to the ECG waveforms.

Four different filters can be applied and the cut-off frequency can be adjusted, namely:

- A low-pass filter with default cut-off frequency of 40 Hz
- An high-pass filter with default cut-off frequency of 0.01 Hz
- A notch filter with default cut-off frequency of 60 Hz
- A second notch filter with default cut-off frequency of 50 Hz

In the output dialog the “Enable Filters” checkbox must be enabled in order to apply filtering. To configure the order of filtering and the cut-off frequency of each filter, the “Config Filters” button shall be pressed. Here a dialog is shown, allowing to modify the filter settings and the filtering sequence.

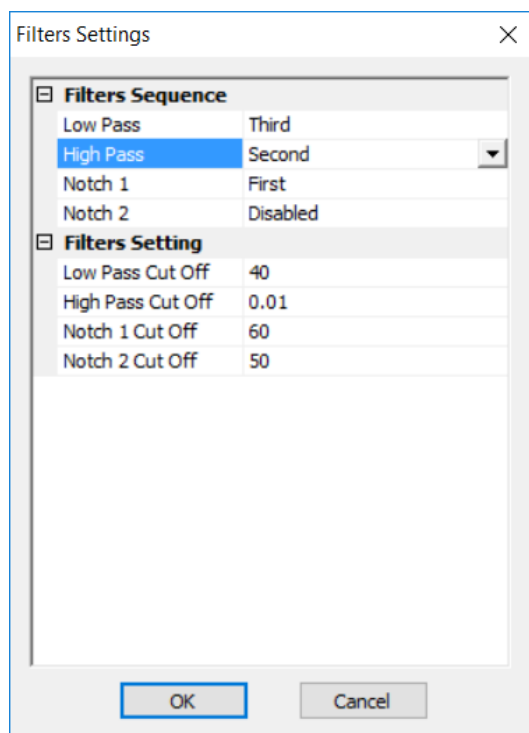


Figure 125 – Filtering configuration dialog.

3.26.4. ACEA XML

The software, if the related output plugin has been installed, allows the exportation of the entire performed analysis results and settings in XML format.


This can then allow the importation of analysis results in a database.

Refer to section 3.5 of the System Manual for the structure of ACEA XML.

3.26.5. Detailed analysis segments export

In case of multiday analysis, to export selected detailed analysis segments that have been previously selected via Rhythms display (section 3.15.1) Rhythm and Beat editor (section 3.7.5), select “Cut and Export Record” entry from File menu.

3.27. Continuous ECG Report

At any time during a session of Beat or Arrhythmia Editing, it is possible to print a Continuous ECG Report by selecting the "Print Report" entry from the File menu, by clicking the  button.

Report can be printed to a standard printer or saved in PDF format and here it is possible to specify the sheet size between Letter and A4.

The first page of the Report (Figure 126) always includes a summary of Demographic information, the list of medications and referring physician, if available, and at the end the Cardiologist's review statement is reported. This report can be added by clicking the "Add Comment" button from the "Report Options" dialog (Figure 128).

In the footer of each page there is the date when the report was printed and the information of the software version.

In the Analysis Data section, the main results are reported, namely:

- Total number of QRS
- Overall length of analyzed date and length on noise regions
- Min/max/mean HR and RR
- Episodes and overall length of manually insertable events
 - Atrial Fibrillation, Atrial Flutter, Atrial Tachycardia
 - Ventricular Fibrillation, Ventricular Flutter, Torsade de Pointes
 - AVBs
- Details for VPB and SVPB, including overall number, isolated, couplets, run...
- VT and SVT details
- Episodes of Bradycardia, Pauses and Prolonged RR
- HRV results on the entire recording (if HRV module is available): PNN50, SDNN, RMSSD
- Details of ST Elevation/Depression episodes, per measured lead
 - Total duration of ST displacement episodes
 - Maximum ST Elevation
 - Maximum ST Depression
 - Length of maximum ST displacement episode
 - Maximum HR in any ST displacement episode

In the Analysis Settings section, the details of ABILE and BRAVO settings for Beat Detection, Rhythm Analysis and Beat measure are reported, namely:

- Leads used for Beat Detection
- Noise sensitivity level
- Prematurity index
- Average RR (RRp) Window size
- Prolonged RR threshold
- Pause threshold
- Bradycardia threshold and minimum length
- Supraventricular Tachycardia threshold and minimum length
- Ventricular Tachycardia threshold and minimum length
- Minimum length of atrial fibrillation, in case the specified value is above 0 s

- Measured Leads in Beat Measure
- Family Time-bin size
- Start Elevation point
- Nb of elevation points
- Distance between elevation points
- Elevation Threshold

Center ABCD**Continuous ECG Report**

Subject Data	Study & Visit Data	Machine Data											
ID: 4-a Name: AJK Date of Birth: --- Age: --- Gender: Male	Protocol ID: Study ABCD Site ID: Site0001 Investigator ID: --- Visit ID: P1D1 Date & Time: 19-Dec-2001 07:43:00 Duration: 23:38:00	Device: H12.Cont.2.02 Device ID: --- Software: --- Manufacturer : ---											
Treatment Cumadin Referred by: Dr. Johansson													
Analysis Data <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> Total QRS: 92437 Analyzed Data: 23:35:20, Noise: 00:02:06 (0.1%) Atrial Fibrillation: 2, total duration: 00:04:27 (0.31%) Atrial Tachycardia: 1, total duration: 00:00:11 Atrioventricular Block: 1 VPB Total Number: 119 (0.13%) Isolated V: 111 Ventricular Couplets: 4 Ventricular Run: 0 - Longest : - - Fastest : - V Bigeminy: 0 V Trigeminy: 0 Ventricular Tachycardia: 0 Bradycardia: 4 - Longest at 05:58:27, 30.00 s, HR: 44 bpm - Slowest at 05:58:27, 30.00 s, HR: 44 bpm Pauses: 1, Longest: 3.78s, at 12:41:40 HRV PNN50: 16.28 % SDNN: 151.87 ms RMSSD: 49.34 ms </td> <td style="width: 50%; vertical-align: top;"> <table style="width: 100%; border: none;"> <tr> <th style="text-align: left; padding: 2px;">Min</th> <th style="text-align: left; padding: 2px;">Max</th> <th style="text-align: left; padding: 2px;">Avr</th> </tr> <tr> <td style="padding: 2px;">RR (ms) 456 (16:10:05)</td> <td style="padding: 2px;">3778 (12:41:44)</td> <td style="padding: 2px;">920</td> </tr> <tr> <td style="padding: 2px;">HR (bpm) 43 (05:35:11)</td> <td style="padding: 2px;">105 (14:30:58)</td> <td style="padding: 2px;">67</td> </tr> </table> SVPB Total Number: 178 (0.19%) Isolated S: 45 Supraventricular Couplets: 27 Supraventricular Run: 6 - Longest at 06:19:06, 35 beats, HR: 84 bpm - Fastest at 12:16:38, 3 beats, HR: 139 bpm SV Bigeminy: 0 SV Trigeminy: 0 Supraventricular Tachycardia: 0 Prolonged RR Interval: 7, Longest: 2.10s, at 08:05:38 </td> </tr> </table>			Total QRS: 92437 Analyzed Data: 23:35:20, Noise: 00:02:06 (0.1%) Atrial Fibrillation: 2, total duration: 00:04:27 (0.31%) Atrial Tachycardia: 1, total duration: 00:00:11 Atrioventricular Block: 1 VPB Total Number: 119 (0.13%) Isolated V: 111 Ventricular Couplets: 4 Ventricular Run: 0 - Longest : - - Fastest : - V Bigeminy: 0 V Trigeminy: 0 Ventricular Tachycardia: 0 Bradycardia: 4 - Longest at 05:58:27, 30.00 s, HR: 44 bpm - Slowest at 05:58:27, 30.00 s, HR: 44 bpm Pauses: 1, Longest: 3.78s, at 12:41:40 HRV PNN50: 16.28 % SDNN: 151.87 ms RMSSD: 49.34 ms	<table style="width: 100%; border: none;"> <tr> <th style="text-align: left; padding: 2px;">Min</th> <th style="text-align: left; padding: 2px;">Max</th> <th style="text-align: left; padding: 2px;">Avr</th> </tr> <tr> <td style="padding: 2px;">RR (ms) 456 (16:10:05)</td> <td style="padding: 2px;">3778 (12:41:44)</td> <td style="padding: 2px;">920</td> </tr> <tr> <td style="padding: 2px;">HR (bpm) 43 (05:35:11)</td> <td style="padding: 2px;">105 (14:30:58)</td> <td style="padding: 2px;">67</td> </tr> </table> SVPB Total Number: 178 (0.19%) Isolated S: 45 Supraventricular Couplets: 27 Supraventricular Run: 6 - Longest at 06:19:06, 35 beats, HR: 84 bpm - Fastest at 12:16:38, 3 beats, HR: 139 bpm SV Bigeminy: 0 SV Trigeminy: 0 Supraventricular Tachycardia: 0 Prolonged RR Interval: 7, Longest: 2.10s, at 08:05:38	Min	Max	Avr	RR (ms) 456 (16:10:05)	3778 (12:41:44)	920	HR (bpm) 43 (05:35:11)	105 (14:30:58)	67
Total QRS: 92437 Analyzed Data: 23:35:20, Noise: 00:02:06 (0.1%) Atrial Fibrillation: 2, total duration: 00:04:27 (0.31%) Atrial Tachycardia: 1, total duration: 00:00:11 Atrioventricular Block: 1 VPB Total Number: 119 (0.13%) Isolated V: 111 Ventricular Couplets: 4 Ventricular Run: 0 - Longest : - - Fastest : - V Bigeminy: 0 V Trigeminy: 0 Ventricular Tachycardia: 0 Bradycardia: 4 - Longest at 05:58:27, 30.00 s, HR: 44 bpm - Slowest at 05:58:27, 30.00 s, HR: 44 bpm Pauses: 1, Longest: 3.78s, at 12:41:40 HRV PNN50: 16.28 % SDNN: 151.87 ms RMSSD: 49.34 ms	<table style="width: 100%; border: none;"> <tr> <th style="text-align: left; padding: 2px;">Min</th> <th style="text-align: left; padding: 2px;">Max</th> <th style="text-align: left; padding: 2px;">Avr</th> </tr> <tr> <td style="padding: 2px;">RR (ms) 456 (16:10:05)</td> <td style="padding: 2px;">3778 (12:41:44)</td> <td style="padding: 2px;">920</td> </tr> <tr> <td style="padding: 2px;">HR (bpm) 43 (05:35:11)</td> <td style="padding: 2px;">105 (14:30:58)</td> <td style="padding: 2px;">67</td> </tr> </table> SVPB Total Number: 178 (0.19%) Isolated S: 45 Supraventricular Couplets: 27 Supraventricular Run: 6 - Longest at 06:19:06, 35 beats, HR: 84 bpm - Fastest at 12:16:38, 3 beats, HR: 139 bpm SV Bigeminy: 0 SV Trigeminy: 0 Supraventricular Tachycardia: 0 Prolonged RR Interval: 7, Longest: 2.10s, at 08:05:38	Min	Max	Avr	RR (ms) 456 (16:10:05)	3778 (12:41:44)	920	HR (bpm) 43 (05:35:11)	105 (14:30:58)	67			
Min	Max	Avr											
RR (ms) 456 (16:10:05)	3778 (12:41:44)	920											
HR (bpm) 43 (05:35:11)	105 (14:30:58)	67											
Analysis Settings Analysis Software: CER-S v3.2.0SPRINT9_BETA12 - Beat Detection (ABILE v1.5.0) - Rhythm Analysis (ABILE v1.5.0) <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> BEAT DETECTION - Leads used for detection: I II V2 RHYTHM ANALYSIS - Prematurity index: 75% - Prolonged RR Interval Threshold: 200% - Bradycardia Threshold: 45 bpm, Min. Len.: 10.0 s - Vent. Tachycardia Thresh.: 150 bpm, Min. Len.: 5.0 s - Atrial Fibrillation, Min. Len.: 60 s </td> <td style="width: 50%; vertical-align: top;"> - Noise sensitivity level: High - Average RR Window size: 8 - Pause Threshold: 2.5 s - Supravent. Tachycardia Thresh.: 150 bpm, Min. Len.: 5.0 s </td> </tr> </table>			BEAT DETECTION - Leads used for detection: I II V2 RHYTHM ANALYSIS - Prematurity index: 75% - Prolonged RR Interval Threshold: 200% - Bradycardia Threshold: 45 bpm, Min. Len.: 10.0 s - Vent. Tachycardia Thresh.: 150 bpm, Min. Len.: 5.0 s - Atrial Fibrillation, Min. Len.: 60 s	- Noise sensitivity level: High - Average RR Window size: 8 - Pause Threshold: 2.5 s - Supravent. Tachycardia Thresh.: 150 bpm, Min. Len.: 5.0 s									
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Review Normal Sinus Rhythm with relevant ventricular activity. More than 500 isolated VPV, 50+ couplets and 5 run, one lasting more than 14 minutes. Date of Analysis _____ Reviewer: _____													

Printed on Friday, December 14, 2018 11:14:21 - with CER-S 3.2.0SPRINT9_BETA12

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Figure 126 – Example of first page of a Continuous ECG Report, without Beat Measure analysis

Cleveland Clinic		Continuous ECG Report																																																															
Subject Data ID: --- Name: DEROBERT Date of Birth: 01-Jan-2002 Age: 2 Gender: Male		Study & Visit Data Protocol ID: --- Site ID: --- Investigator ID: --- Visit ID: --- Date & Time: 02-Dec-2004 09:35:49 Duration: 23:59:55																																																															
Machine Data Device: sl0212005 3.01k Device ID: --- Software: --- Manufacturer : ---																																																																	
Treatment amiodarone Referred by: Dr. Goldenberg																																																																	
Analysis Data <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> Total QRS: 92127 Analyzed Data: 23:55:08, Noise: 00:03:34 (0.2%) Atrial Fibrillation: - VPB Total Number: 35 (0.04%) Isolated V: 35 Ventricular Couplets: 0 Ventricular Run: 0 - Longest : - - Fastest : - V Bigeminy: 0 V Trigeminy: 0 Ventricular Tachycardia: 0 Bradycardia: 0 Pauses: 0 HRV PNN50: 19.76 % SDNN: 163.68 ms RMSSD: 60.02 ms ST <table style="width: 100%; border: none;"> <tr> <td style="width: 10%;">Channel:</td> <td style="width: 10%;">V1</td> <td style="width: 10%;">V2</td> <td style="width: 10%;">V3</td> <td style="width: 10%;">V4</td> <td style="width: 10%;">V5</td> <td style="width: 10%;">V6</td> </tr> <tr> <td>total duration:</td> <td>13'</td> <td>-</td> <td>23h 57'</td> <td>-</td> <td>12h 17'</td> <td>14h 3'</td> </tr> <tr> <td>Max ST Elevation(uV):</td> <td>620</td> <td>-</td> <td>1150</td> <td>-</td> <td>880</td> <td>210</td> </tr> <tr> <td>Max ST Depression(uV):</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-170</td> <td>-3080</td> </tr> <tr> <td>Max ST Episode:</td> <td>13'</td> <td>-</td> <td>23h 57'</td> <td>-</td> <td>2h 23'</td> <td>1h 42'</td> </tr> <tr> <td>Max HR in ST Episode(bmp):</td> <td>81</td> <td>-</td> <td>105</td> <td>-</td> <td>95</td> <td>105</td> </tr> </table> </td> <td style="width: 50%; vertical-align: top;"> <table style="width: 100%; border: none;"> <tr> <td style="width: 10%;"></td> <td style="width: 10%;">Min</td> <td style="width: 10%;"></td> <td style="width: 10%;">Max</td> <td style="width: 10%;"></td> <td style="width: 10%;">Avr</td> </tr> <tr> <td>RR (ms)</td> <td>450</td> <td>(14:17:39)</td> <td>1510</td> <td>(06:46:23)</td> <td>936</td> </tr> <tr> <td>HR (bpm)</td> <td>47</td> <td>(01:15:06)</td> <td>108</td> <td>(11:06:47)</td> <td>67</td> </tr> </table> SVPB Total Number: 134 (0.15%) Isolated S: 98 Supraventricular Couplets: 13 Supraventricular Run: 3 - Longest at 03:57:39, 4 beats, HR: 123 bpm - Fastest at 11:04:00, 3 beats, HR: 140 bpm SV Bigeminy: 0 SV Trigeminy: 1, Longest (6.18 s) at 09:32:58 Supraventricular Tachycardia: 0 </td> </tr> </table>				Total QRS: 92127 Analyzed Data: 23:55:08, Noise: 00:03:34 (0.2%) Atrial Fibrillation: - VPB Total Number: 35 (0.04%) Isolated V: 35 Ventricular Couplets: 0 Ventricular Run: 0 - Longest : - - Fastest : - V Bigeminy: 0 V Trigeminy: 0 Ventricular Tachycardia: 0 Bradycardia: 0 Pauses: 0 HRV PNN50: 19.76 % SDNN: 163.68 ms RMSSD: 60.02 ms ST <table style="width: 100%; border: none;"> <tr> <td style="width: 10%;">Channel:</td> <td style="width: 10%;">V1</td> <td style="width: 10%;">V2</td> <td style="width: 10%;">V3</td> <td style="width: 10%;">V4</td> <td style="width: 10%;">V5</td> <td style="width: 10%;">V6</td> </tr> <tr> <td>total duration:</td> <td>13'</td> <td>-</td> <td>23h 57'</td> <td>-</td> <td>12h 17'</td> <td>14h 3'</td> </tr> <tr> <td>Max ST Elevation(uV):</td> <td>620</td> <td>-</td> <td>1150</td> <td>-</td> <td>880</td> <td>210</td> </tr> <tr> <td>Max ST Depression(uV):</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-170</td> <td>-3080</td> </tr> <tr> <td>Max ST Episode:</td> <td>13'</td> <td>-</td> <td>23h 57'</td> <td>-</td> <td>2h 23'</td> <td>1h 42'</td> </tr> <tr> <td>Max HR in ST Episode(bmp):</td> <td>81</td> <td>-</td> <td>105</td> <td>-</td> <td>95</td> <td>105</td> </tr> </table>	Channel:	V1	V2	V3	V4	V5	V6	total duration:	13'	-	23h 57'	-	12h 17'	14h 3'	Max ST Elevation(uV):	620	-	1150	-	880	210	Max ST Depression(uV):	-	-	-	-	-170	-3080	Max ST Episode:	13'	-	23h 57'	-	2h 23'	1h 42'	Max HR in ST Episode(bmp):	81	-	105	-	95	105	<table style="width: 100%; border: none;"> <tr> <td style="width: 10%;"></td> <td style="width: 10%;">Min</td> <td style="width: 10%;"></td> <td style="width: 10%;">Max</td> <td style="width: 10%;"></td> <td style="width: 10%;">Avr</td> </tr> <tr> <td>RR (ms)</td> <td>450</td> <td>(14:17:39)</td> <td>1510</td> <td>(06:46:23)</td> <td>936</td> </tr> <tr> <td>HR (bpm)</td> <td>47</td> <td>(01:15:06)</td> <td>108</td> <td>(11:06:47)</td> <td>67</td> </tr> </table> SVPB Total Number: 134 (0.15%) Isolated S: 98 Supraventricular Couplets: 13 Supraventricular Run: 3 - Longest at 03:57:39, 4 beats, HR: 123 bpm - Fastest at 11:04:00, 3 beats, HR: 140 bpm SV Bigeminy: 0 SV Trigeminy: 1, Longest (6.18 s) at 09:32:58 Supraventricular Tachycardia: 0		Min		Max		Avr	RR (ms)	450	(14:17:39)	1510	(06:46:23)	936	HR (bpm)	47	(01:15:06)	108	(11:06:47)	67
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Review Suspected Brugada Date of Analysis _____ Reviewer: _____																																																																	

Printed on Wednesday, January 02, 2019 15:18:27 - with CER-S 3.2.0SPRINT9_BETA13

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Figure 127 – Example of first page of a Continuous ECG Report, with Beat Measure analysis

When the "Print Report" entry has been selected, the "Report Options" dialog is prompted (Figure 128) where it is possible to choose and configure the sections that should be included in the report.

It is possible to configure the report's language (current available languages are English, French and Italian), via the Language drop-down menu.

The "Center ID" is manually editable and it will be printed on the report's header.

Figure 128 – "Report Options" dialog for the selection of the sections to be included in the report

Clicking the "Demographics" button, it is possible to display and edit the record's demographics (refer to section 3.28 for details).

Clicking on the "Review" button, the review dialog is displayed. See section 3.27.1 for details.

Available sections that can be included in the Continuous ECG Report, depending on the available analysis modules and analysis results, are:

- "RR Average Plot" (see Figure 129) - Time RR average plot displays the average values of RR interval over time.
 - The size of the window to compute the average RR is customizable, between and 1 and 60 minutes.
 - Display of minimum/maximum values and standard deviation can be enabled.
 - RR Extrema for each average window can be displayed.
- "Rhythms Plot" - Rhythm Annotations against time (see Figure 130): number of Rhythm Annotations and the time of occurrence for each episode.
 - Rhythm annotations reported in the plot can be limited only to the ones available on the given record.
- "Rhythms List" - List of significant arrhythmias (see Figure 131)
 The full list of the following rhythms event can be reported, sorted by severity and reporting: start time, length and other details, depending on the event

- Atrial Fibrillation (min/max heart-rate is reported for each event type)
 - Pauses
 - Ventricular Tachycardia (number of beats and mean/min/max heart-rate are reported for each event)
 - Supraventricular Tachycardia (number of beats and mean/min/max heart-rate are reported for each event)
 - Ventricular runs (number of beats and mean/min/max heart-rate are reported for each event)
 - Supraventricular runs (number of beats and mean/min/max heart-rate are reported for each event)
- Table - summary information for ECG beats and Rhythm Annotations in tabular format (see Figure 132).
 - Table layout follows the one selected for the graphical display, namely the columns to be reported, the size of time Bins and the initial time (refer to section 3.12.2 for the details).
 - As there are several columns and rows to be reported, the Table will be split in two or more sections to fit the page size.
- Templates - Templates waveforms for each beat type, one type per page (Figure 136).
 - Templates will follow the QRS complex visualization (refer to section 3.13.3 for the details).
 - If three or more leads were used in the Beat Detection process, the first three leads will be reported. Otherwise in case one or two leads were used, these will be printed.
 - Leads will be printed not superimposed and at 50mm/s and 10 mm/mV.
- Selected ECG Strips (Figure 133, Figure 134 and Figure 135)
 - This choice is only available if ECG Strips have been selected for printing (refer to sections 3.7.1.3 and 3.4.11 for details).
 - Strips can be printed in three layouts: 3 or 12 Leads at 25mm/s and 5 mm/mV and miniature single-lead at 12.5mm/s and 5 mm/mV.
 - In case of 3 leads, these will be II, V2 and V5 in case of a 12 lead continuous ECG recording
 - In case of miniature, in addition of the ECG signal, drawn in 1, 2 or 3 lines, depending on the ECG length, a 5 minutes RR, cantered on the printed strip, plot is added at the bottom.
 - If the length of the strip is 7s, it will be printed on a single line. Otherwise will be split on multiple lines, each of 7s length, with a maximum of 42s.
- Automatic ECG Strips
Print automatic ECG strips. The list of the printable automatic strips can be configured in the "Automatic Strips Options Dialog" (see section 3.29.3 for details).
- Full Disclosure - The entire ECG recording signal can be printed in small size (60s per line). Three layouts are available
 - 1 Lead (1 hour per page)
 - 2 Leads (30 minutes per page)
 - 3 Leads (20 minutes per page)
- ST Plot and ST Table, in case episodes of ST Elevation/Depression have been identified.

- ST Plot reports the maximum Elevation/Depression for each family and on each lead; in case of ST displacement evaluation computed on multiple points, the maximum displacement assessed from all points is reported.
- ST Table reports the list of all episodes of ST displacement, on all analysed leads with onset, duration, maximum displacement and average heart rate.

RR Average with extrema and Standard Deviation. (RR window = 5 minute(s))

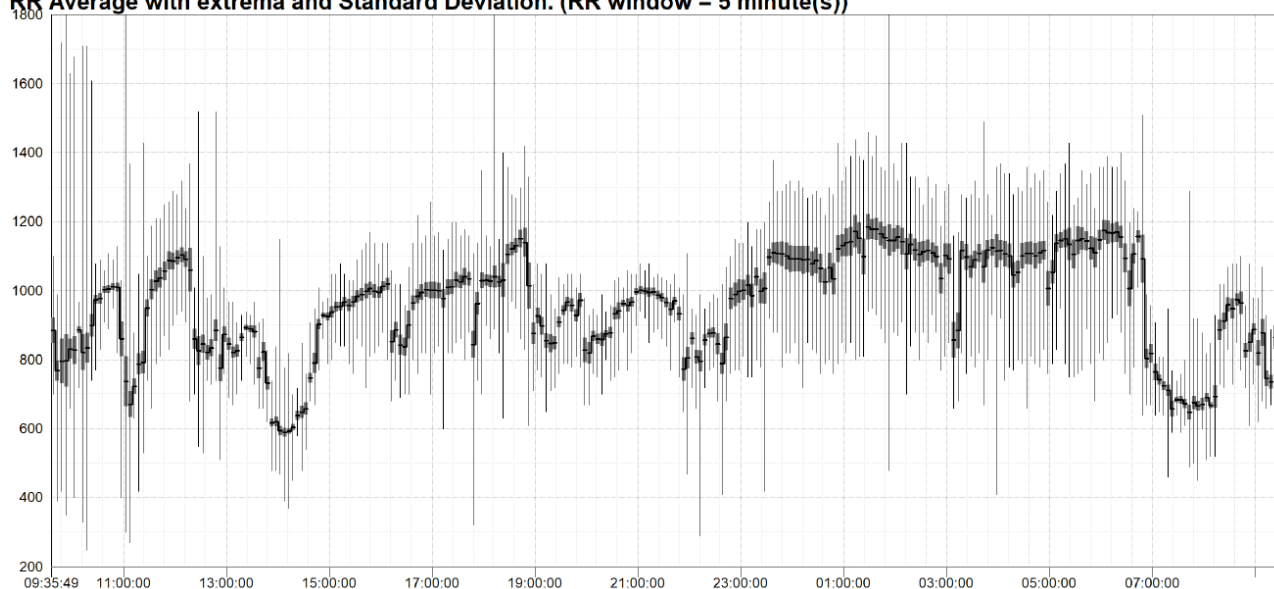


Figure 129 – Example of "RR Average Plot". RR Average, computed over a window of 5 minutes, is visualized as the black thin horizontal line. The gray areas report mean \pm std and the vertical lines report the extreme RR values within each average window

Time-Rhythm Plot

Atrial Fibrillation (2)

Bradycardia (4)

Pause (1)

Prolonged RR Interval (7)

Isolated Supraventricular Beat (45)

Supraventricular Couplet (27)

Supraventricular Run (6)

Atrial Tachycardia (1)

Isolated Ventricular Beat (111)

Ventricular Couplet (4)

AVB (1)

07:43:00 11:00:00 13:00:00 15:00:00 17:00:00 19:00:00 21:00:00 23:00:00 01:00:00 03:00:00 05:00:00 07:21:00

Figure 130 – Example of "Rhythm Plot". Rhythm annotations are listed with the number of events and their time of occurrence as a black vertical line

Rhythms List		
Atrial Fibrillation		
Start Time: 17:16:16	Length: 2min 35s 722ms	HR min/max: 69/83 bpm
Start Time: 15:05:36	Length: 2min 8s 211ms	HR min/max: 57/74 bpm
Start Time: 23:26:46	Length: 1min 51s 366ms	HR min/max: 55/73 bpm
Start Time: 02:26:24	Length: 1min 49s 666ms	HR min/max: 58/77 bpm
Start Time: 09:55:50	Length: 1min 5s 988ms	HR min/max: 64/74 bpm
Start Time: 14:12:10	Length: 1min 3s 488ms	HR min/max: 76/83 bpm
Start Time: 18:06:44	Length: 56s 866ms	HR min/max: 53/66 bpm
Start Time: 18:04:42	Length: 38s 88ms	HR min/max: 56/74 bpm
Start Time: 20:20:04	Length: 37s 255ms	HR min/max: 58/77 bpm
Start Time: 21:30:04	Length: 36s 577ms	HR min/max: 56/62 bpm
Start Time: 14:06:28	Length: 35s 888ms	HR min/max: 65/78 bpm
Start Time: 05:27:22	Length: 35s 55ms	HR min/max: 59/71 bpm
Pause		
Start Time: 17:46:32	Length: 4s 166ms	
Start Time: 09:50:16	Length: 3s 533ms	

Figure 131 – Example of "Rhythm List", listing all episodes of Atrial Fibrillation and Pause. In the Report Options dialog it is possible to select which list of events to be included in the report.

Time	Analyzed Time	RR Min	RR Max	RR Average	RR StDev	HR Min	HR Max	HR Average	HR StDev	Brady	Pauses	Prolonged RR Intervals	SVPB Isolated	SV Couplet	SV Run	SV Bg	SV Tg
07:43:00 - 08:59:59	01:16:57 (100.0%)	656	2100	1043	108.75	49	90	58	9.53	-	-	1	2	2	-	-	-
09:00:00 - 10:59:59	01:59:31 (99.6%)	567	1556	896	117.69	49	103	68	11.99	-	-	-	5	1	-	-	-
11:00:00 - 12:59:59	01:59:20 (99.4%)	478	3778	896	118.91	53	99	68	8.15	-	1(L: 3.8s)	3	8	2	1	-	-
13:00:00 - 14:59:59	01:58:50 (99.0%)	522	1644	817	112.89	56	105	74	12.11	-	-	2	19	7	1	-	-
15:00:00 - 16:59:59	01:59:53 (99.9%)	456	1489	849	98.11	59	105	71	9.40	-	-	-	3	5	-	-	-
17:00:00 - 18:59:59	01:59:59 (100%)	556	1556	860	112.48	56	98	70	12.99	-	-	-	-	1	1	-	-
19:00:00 - 20:59:59	01:59:52 (99.9%)	544	1433	774	83.37	60	105	78	9.50	-	-	-	2	3	-	-	-
21:00:00 - 22:59:59	02:00:00 (100%)	567	1756	890	114.34	56	98	68	7.77	-	-	-	-	-	-	-	-
23:00:00 - 00:59:59	02:00:00 (100%)	544	2089	946	127.77	46	100	64	11.03	-	-	1	2	4	1	-	-
01:00:00 - 02:59:59	01:59:56 (100.0%)	633	1467	1108	109.41	46	90	54	10.76	-	-	-	-	2	1	-	-
03:00:00 - 04:59:59	01:59:59 (100%)	600	1444	1099	113.86	45	90	54	11.59	-	-	-	1	-	-	-	-
05:00:00 - 06:59:59	01:59:59 (100%)	600	1578	1048	153.82	43	91	58	10.40	4	-	-	2	-	1	-	-
07:00:00 - 07:21:00	00:20:58 (99.9%)	622	1167	867	117.95	53	89	69	13.70	-	-	-	1	-	-	-	-
All Days: 08:00:00 - 20:00:00	11:57:35 (99.7%)	456	3778	872	123.91	49	105	69	14.69	-	1(L: 3.8s)	6	36	18	3	-	-
All Nights: 23:00:00 - 06:00:00	06:59:56 (100.0%)	544	2089	1052	136.91	43	100	57	13.30	3	-	1	3	6	2	-	-
Entire Recording	23:35:20 (99.8%)	456	3778	920	152.47	43	105	66	15.30	4	1(L: 3.8s)	7	45	27	6	-	-

Figure 132 – Example of "Table" where only few columns are reported and with Time bins of an hour size, starting at the whole hour

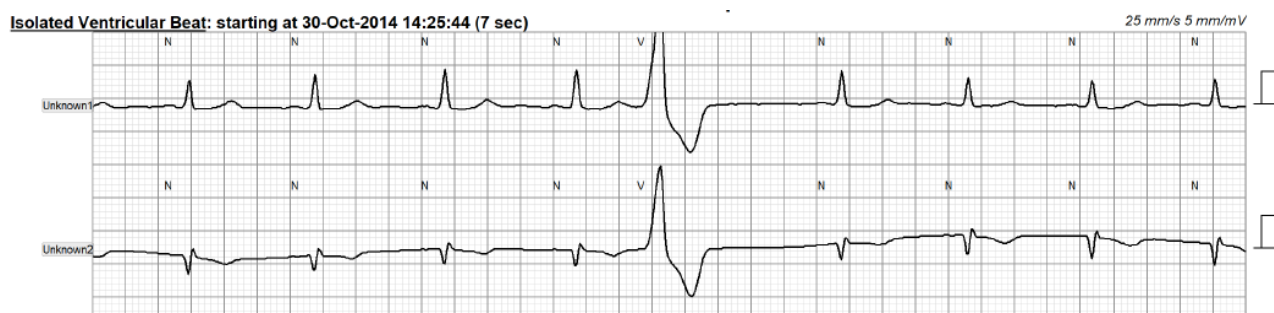


Figure 133 – Example of "ECG Strip" with 3-Leads layout

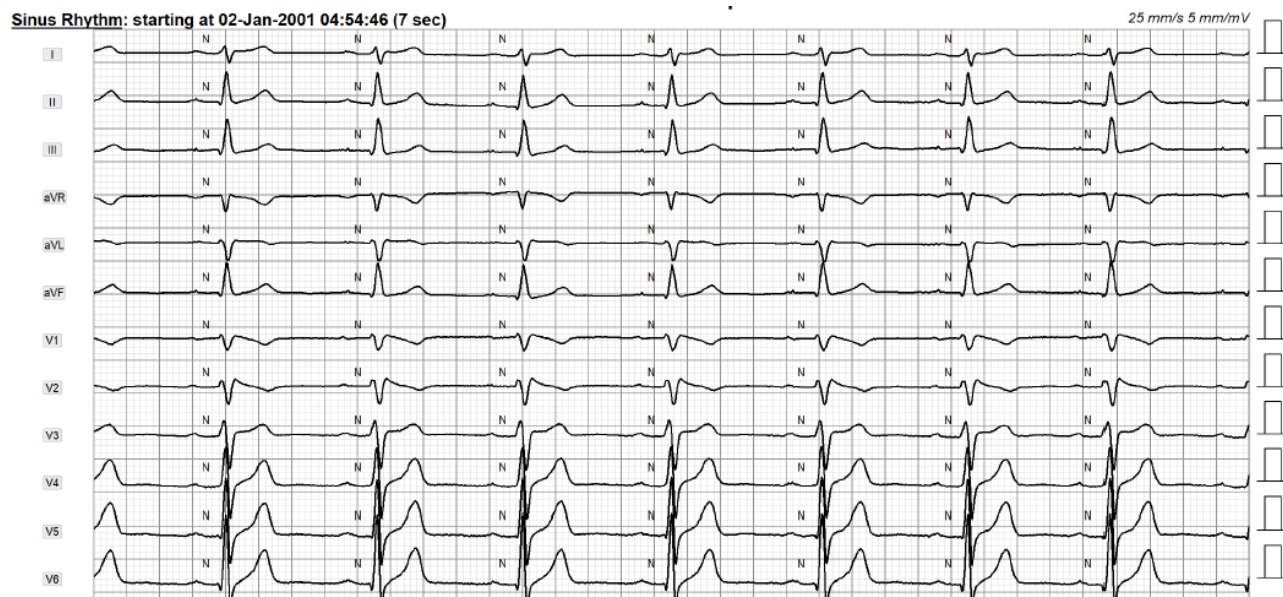


Figure 134 – Example of "ECG Strip" with 12-Leads layout

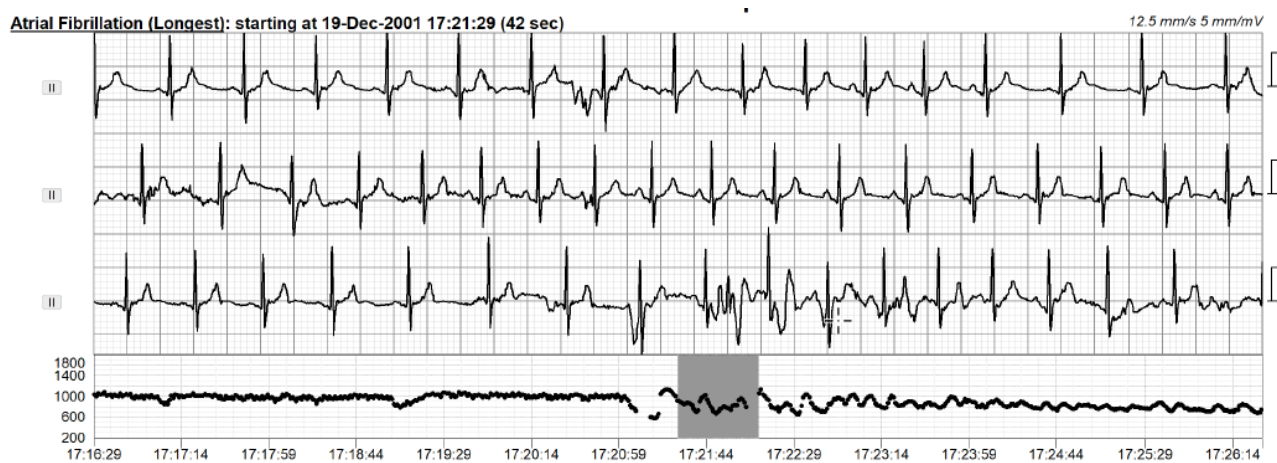


Figure 135 – Example of "ECG Strip" with a length of 42s in Miniature layout



Figure 136 – Example of first page of "Templates" of type N, where leads II, V2 and V5 are reported for the QRS complex segment

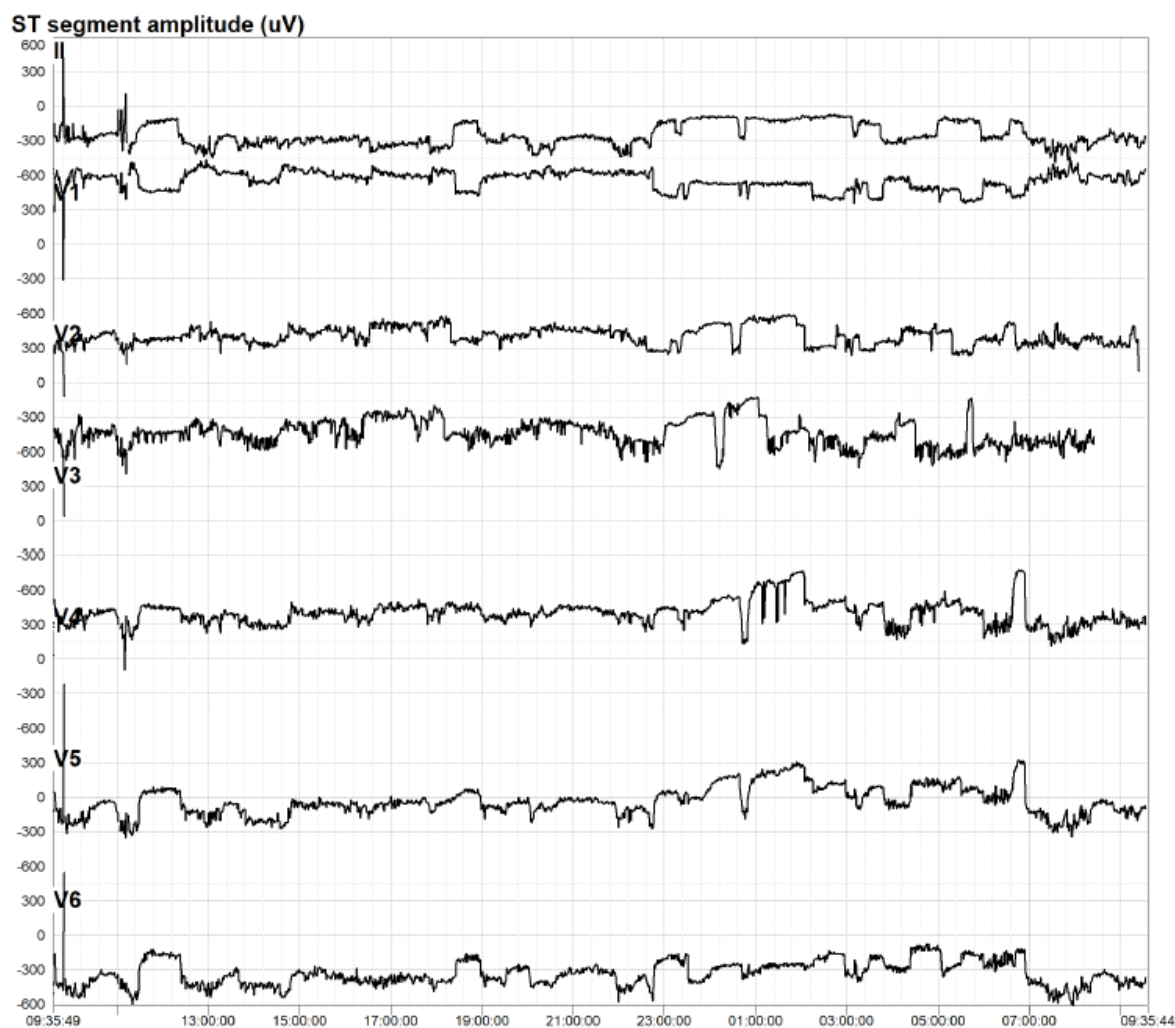


Figure 137 – Example ST segment displacement plot, where ST amplitude on each lead is reported

Onset	Duration	Max(uV)	Channel	HR mean
12/02/2004 09:36:49	00:12:00	-280	II	74
12/02/2004 09:48:49	00:01:00	430	II	73
12/02/2004 09:49:49	01:12:00	-330	II	66
12/02/2004 11:03:49	00:01:00	-190	II	84
12/02/2004 11:05:49	00:04:00	-360	II	89
12/02/2004 11:10:49	00:01:00	120	II	84
12/02/2004 11:11:49	00:45:00	-390	II	62
12/02/2004 11:57:49	00:05:00	-120	II	55
12/02/2004 12:03:49	00:01:00	-110	II	54
12/02/2004 12:06:49	00:03:00	-110	II	54
12/02/2004 12:10:49	00:01:00	-110	II	54
12/02/2004 12:15:49	00:01:00	-110	II	54
12/02/2004 12:19:49	10:45:00	-420	II	65
12/02/2004 23:05:49	00:03:00	-120	II	58
12/02/2004 23:11:49	00:01:00	-120	II	60
12/02/2004 23:13:49	00:14:00	-230	II	59
12/03/2004 00:35:49	00:10:00	-270	II	57
12/03/2004 01:11:49	00:02:00	-110	II	50
12/03/2004 01:16:49	00:04:00	-120	II	52
12/03/2004 01:21:49	00:03:00	-120	II	54
12/03/2004 01:25:49	00:03:00	-110	II	50
12/03/2004 01:29:49	00:01:00	-110	II	52
12/03/2004 01:31:49	00:02:00	-120	II	51

Figure 138 – Example ST segment displacement tale, where for each identified ST episode on each lead, onset, duration, maximum displacement, mean heart rate are reported.



Figure 139 – Example ST segment displacement tale, where for each identified ST episode on each lead, onset, duration, maximum displacement, mean heart rate are reported.

3.27.1. Review Dialog

Review [X]

Analysis Data

Total QRS: 117252
 Analyzed Data: 23:30:35, Noise: 00:03:25 (0.2%)
 Atrial Fibrillation: 10, total duration: 00:06:57 (0.49%)
 VPB
 Total Number: 155 (0.13%)
 Isolated V: 57
 Ventricular Couplets: 3
 Ventricular Run: 19
 - Longest at 14:01:38, 10 beats, HR: 51 bpm
 - Fastest at 13:57:57, 4 beats, HR: 135 bpm
 V Bigeminy: 0
 V Trigeminy: 0
 Ventricular Tachycardia: 0
 Bradycardia: 4

Comments (type comments here)

Total QRS: 117252

Predefined sentences

Subjects presented fibrillation episodes
 There was a total of xx ventricular ectopic beats during the monitored period
 There was a total of xx supraventricular ectopic beats during the monitored period

Add selected
 New...
 Edit

OK Cancel

Figure 140 – Report Review Dialog

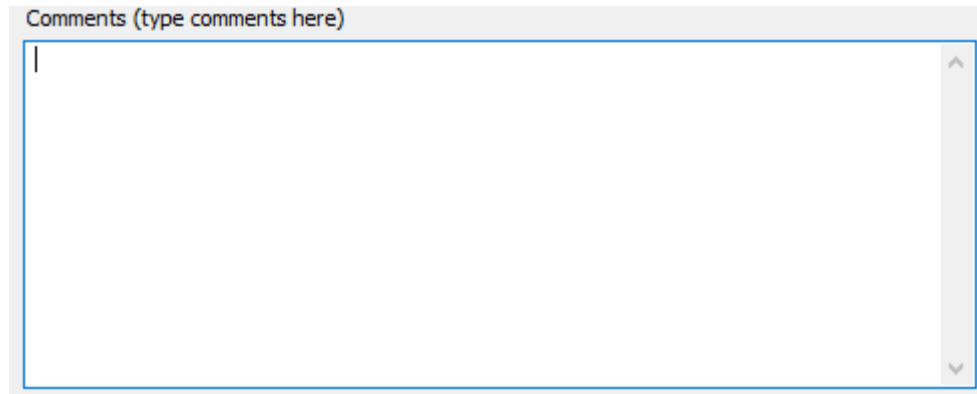
In the *Review Dialog* is possible to:

- Review the analysis data (read-only) where information about the beats and the rhythm annotations is reported

Analysis Data

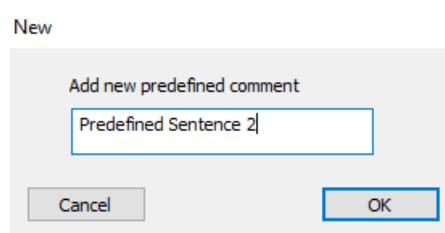
Total QRS: 6537
 Analyzed Data: 01:30:58, Noise: 00:07:07 (7.3%)
 RR min: 200 ms at 06:56:53, RR max: 1736 ms at 07:49:26, RR avr: 842 ms
 HRp min: 57 bpm at 07:33:17, HRp max: 111 bpm at 06:58:19, HRp avr: 73 bpm
 Atrial Fibrillation: 11, total duration: 00:50:44 (51.72%)
 Bradycardia: 0
 Pauses: 0
 Prolonged RR Interval: 6, Longest: 1.74s, at 13:46:05
 VPB
 Total Number: 112 (1.71%)
 Isolated V: 77
 Ventricular Couplets: 12
 Ventricular Run: 3
 - Longest at 06:54:57, 3 beats, HR: 86 bpm

- Write/Edit comments: the comments are displayed and can be entered/modified in the box below.

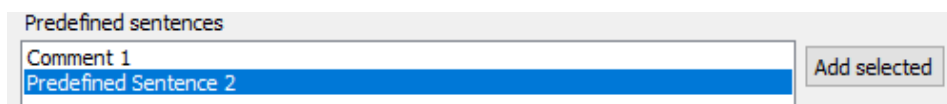


The text displayed in this box will be printed in the "Review" section of the first page of the report.

- Add predefined sentences to comments:
 - Using **New...** button it is possible to create a new predefined sentence Via the input dialog box in which the comment is typed (see figure below).
 -



Pressing the OK button, the typed comment is added to the predefined sentences list as shown below.



- Pressing **Add selected** button, the selected string is added to the comments.
-




- Pressing **Edit** button, the selected string can be modified.

All the created predefined strings are saved in the "PredefinedStrings.txt" configuration file available in the folder storing CER-S settings. Refer to Section 3.3 of the System Manual for the details.

The file can be manually edited. Each predefined string must be separated by a newline character.

3.27.2. Multiday Analysis ECG Report

Also in case of analyzing multiday recordings, it is possible to print a Continuous ECG Report by selecting the "Print Report" entry from the File menu, by clicking the  button. Report can be printed to a standard printer or saved in PDF format.

The main difference from the standard Report is that Analysis Data, Analysis Settings and the reported diagrams are related to Multiday Analysis, thus simplified from for Beat Detection and Rhythm Analysis.

In the Analysis Data section, the main results are reported, namely:

- Overall length of analyzed date and length on noise regions
- Min/max/mean HR and RR
- Episodes and overall length of all events
 - Atrial Fibrillation, Atrial Flutter, Atrial Tachycardia
 - Ventricular Fibrillation, Ventricular Flutter, Torsade de Pointes, Ventricular Tachycardia
 - AVBs
 - Pauses

In the Analysis Settings section, details of ABILE settings for Multiday Analysis reported, namely:

- Leads used for detection
- Noise sensitivity level

- Pause threshold
- Ventricular Tachycardia threshold and minimum length
- Minimum length of atrial fibrillation, in case the specified value is above 0 s

Center ID - ABCD		Continuous ECG Report																					
Subject Data ID: --- Name: DAVID B. Date of Birth: 04-Jan-1983 Age: 35 Gender: Male	Study & Visit Data Protocol ID: --- Site ID: --- Investigator ID: --- Visit ID: --- Date & Time: 09-Nov-2018 11:25:49 Duration: 7d 00:00:00	Machine Data Device: 531119 Device ID: --- Software: --- Manufacturer : ---																					
Treatment phenytoin Referred by: Dr. Jhoansson																							
Analysis Data <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; vertical-align: top;"> Analyzed Data: 6d 19:30:55, Noise: 04:25:17 (2.6%) Atrial Fibrillation: 1, total duration: 00:01:47 (0.02%) Ventricular Tachycardia: 0 Pauses: 3, Longest: 7.45s, at D2 12:03:53 </td> <td style="width: 50%; text-align: right; vertical-align: top;"> <table style="width: 100%; border-collapse: collapse;"> <tr> <th></th> <th>Min</th> <th></th> <th>Max</th> <th></th> <th>Avr</th> </tr> <tr> <td>RR (ms)</td> <td>188</td> <td>(D5 09:53:28)</td> <td>7453</td> <td>(D2 12:04:00)</td> <td>812</td> </tr> <tr> <td>HR (bpm)</td> <td>24</td> <td>(D1 11:25:49)</td> <td>176</td> <td>(D1 11:25:49)</td> <td>78</td> </tr> </table> </td> </tr> </table>				Analyzed Data: 6d 19:30:55, Noise: 04:25:17 (2.6%) Atrial Fibrillation: 1, total duration: 00:01:47 (0.02%) Ventricular Tachycardia: 0 Pauses: 3, Longest: 7.45s, at D2 12:03:53	<table style="width: 100%; border-collapse: collapse;"> <tr> <th></th> <th>Min</th> <th></th> <th>Max</th> <th></th> <th>Avr</th> </tr> <tr> <td>RR (ms)</td> <td>188</td> <td>(D5 09:53:28)</td> <td>7453</td> <td>(D2 12:04:00)</td> <td>812</td> </tr> <tr> <td>HR (bpm)</td> <td>24</td> <td>(D1 11:25:49)</td> <td>176</td> <td>(D1 11:25:49)</td> <td>78</td> </tr> </table>		Min		Max		Avr	RR (ms)	188	(D5 09:53:28)	7453	(D2 12:04:00)	812	HR (bpm)	24	(D1 11:25:49)	176	(D1 11:25:49)	78
Analyzed Data: 6d 19:30:55, Noise: 04:25:17 (2.6%) Atrial Fibrillation: 1, total duration: 00:01:47 (0.02%) Ventricular Tachycardia: 0 Pauses: 3, Longest: 7.45s, at D2 12:03:53	<table style="width: 100%; border-collapse: collapse;"> <tr> <th></th> <th>Min</th> <th></th> <th>Max</th> <th></th> <th>Avr</th> </tr> <tr> <td>RR (ms)</td> <td>188</td> <td>(D5 09:53:28)</td> <td>7453</td> <td>(D2 12:04:00)</td> <td>812</td> </tr> <tr> <td>HR (bpm)</td> <td>24</td> <td>(D1 11:25:49)</td> <td>176</td> <td>(D1 11:25:49)</td> <td>78</td> </tr> </table>		Min		Max		Avr	RR (ms)	188	(D5 09:53:28)	7453	(D2 12:04:00)	812	HR (bpm)	24	(D1 11:25:49)	176	(D1 11:25:49)	78				
	Min		Max		Avr																		
RR (ms)	188	(D5 09:53:28)	7453	(D2 12:04:00)	812																		
HR (bpm)	24	(D1 11:25:49)	176	(D1 11:25:49)	78																		
Analysis Settings Analysis Software: CER-S v3.2.0SPRINT9_BETA12 - Multiday Analysis (ABILE v1.5.0) BEAT DETECTION - Leads used for detection: Generic Bipolar1 Generic Bipolar2 - Noise sensitivity level: High Generic Bipolar3 RHYTHM ANALYSIS - Pause Threshold: 3.5 s - Vent. Tachycardia Thresh.: 130 bpm, Min. Len.: 10.0 s - Atrial Fibrillation, Min. Len.: 90 s																							
Review The test is negative Date of Analysis _____ Reviewer: _____																							

Printed on Wednesday, January 02, 2019 15:23:06 - with CER-S 3.2.0SPRINT9_BETA13
Page 1 of 5

Figure 141 – Example of first page of a Continuous ECG Report, in case of Multiday recording

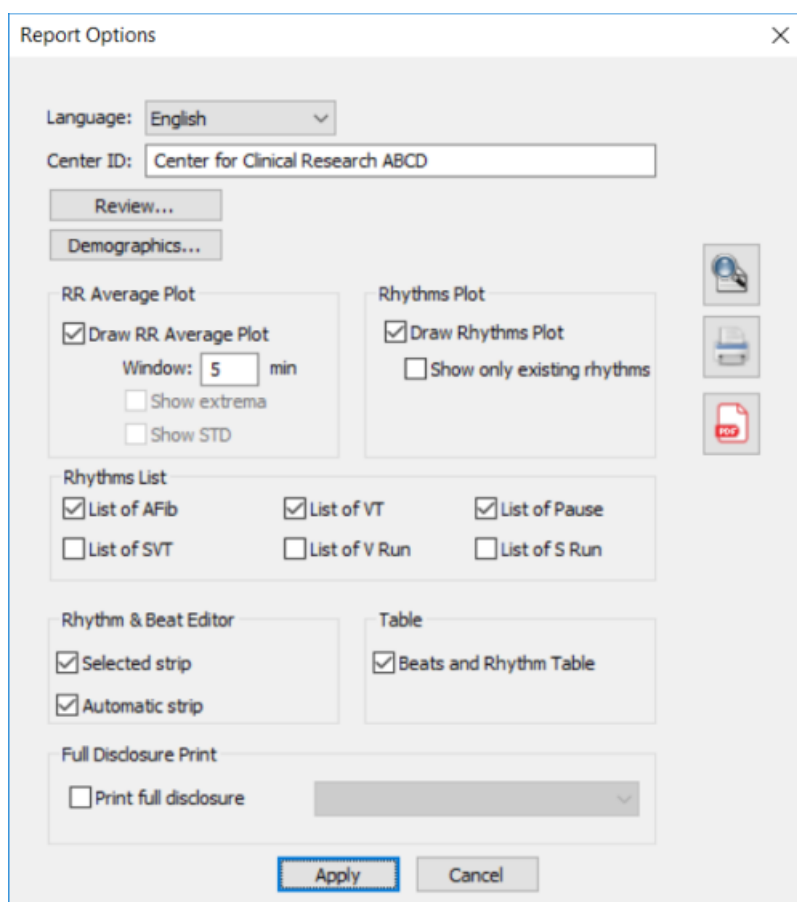
When the "Print Report" entry has been selected, the "Report Options" dialog is prompted (Figure 142 – "Report Options" dialog for the selection of the sections to be included in the Multiday report) where it is possible to choose and configure the sections that should be included in the report.

Available sections that can be included in the Continuous ECG Report in case of Multiday analysis, are:

- “RR Average Plot” - Time RR average plot displays the average values of RR interval over time.
 - The size of the window to compute the average RR is customizable, between and 1 and 60 minutes.
- “Rhythms Plot” - Rhythm Annotations against time (Figure 143): number of Rhythm Annotations and the time of occurrence for each episode.
 - Rhythm annotations reported in the plot can be limited only to the ones available on the given record.
- “Rhythms List” - List of significant arrhythmias (of the following types) sorted by severity and reporting: start time and length
 - Atrial Fibrillation
 - Pauses
 - Ventricular Tachycardia
- Table - summary information for ECG beats and Rhythm Annotations in tabular format (see Figure 132).
 - Table layout follows the one selected for the graphical display, namely the columns to be reported, the size of time Bins and the initial time (refer to section 3.12.2 for the details).
 - As there are several columns and rows to be reported, the Table will be split in two or more sections to fit the page size.
- Selected ECG Strips
 - This choice is only available if ECG Strips have been selected for printing (refer to sections 3.7.1.3 and 3.4.11 for details).
 - Strips can be printed in three layouts: 3 or 12 Leads at 25mm/s and 5 mm/mV and miniature single-lead at 12.5mm/s and 5 mm/mV.
 - In case of 3 leads, these will be II, V2 and V5 in case of a 12 lead continuous ECG recording
 - In case of miniature, in addition of the ECG signal, drawn in 1, 2 or 3 lines, depending on the ECG length, a 5 minutes RR, cantered on the printed strip, plot is added at the bottom.
 - If the length of the strip is 7s, it will be printed on a single line. Otherwise will be split on multiple lines, each of 7s length, with a maximum of 42s.
- Automatic ECG Strips
Print automatic ECG strips. The list of the printable automatic strips can be configured in the “Automatic Strips Options Dialog” (see section 3.29.3 for details).
- Full Disclosure - The entire ECG recording signal can be printed in small size (60s per line). Three layouts are available
 - 1 Lead (1 hour per page)
 - 2 Leads (30 minutes per page)
 - 3 Leads (20 minutes per page)

It is possible to configure the report’s language (current available languages are English, French and Italian), via the Language drop-down menu.

The “Center ID” is manually editable and it will be printed on the report’s header.



The "Report Options" dialog box is used to configure the Multiday report. It includes the following sections:

- Language:** English (dropdown)
- Center ID:** Center for Clinical Research ABCD (text field)
- Buttons:** Review..., Demographics...
- RR Average Plot:**
 - ☒ Draw RR Average Plot
 - Window: 5 min
 - ☐ Show extrema
 - ☐ Show STD
- Rhythms Plot:**
 - ☒ Draw Rhythms Plot
 - ☐ Show only existing rhythms
- Rhythms List:**
 - ☒ List of AFib
 - ☒ List of VT
 - ☒ List of Pause
 - ☐ List of SVT
 - ☐ List of V Run
 - ☐ List of S Run
- Rhythm & Beat Editor:**
 - ☒ Selected strip
 - ☒ Automatic strip
- Table:**
 - ☒ Beats and Rhythm Table
- Full Disclosure Print:**
 - ☐ Print full disclosure
- Buttons:** Apply, Cancel

Figure 142 – "Report Options" dialog for the selection of the sections to be included in the Multiday report

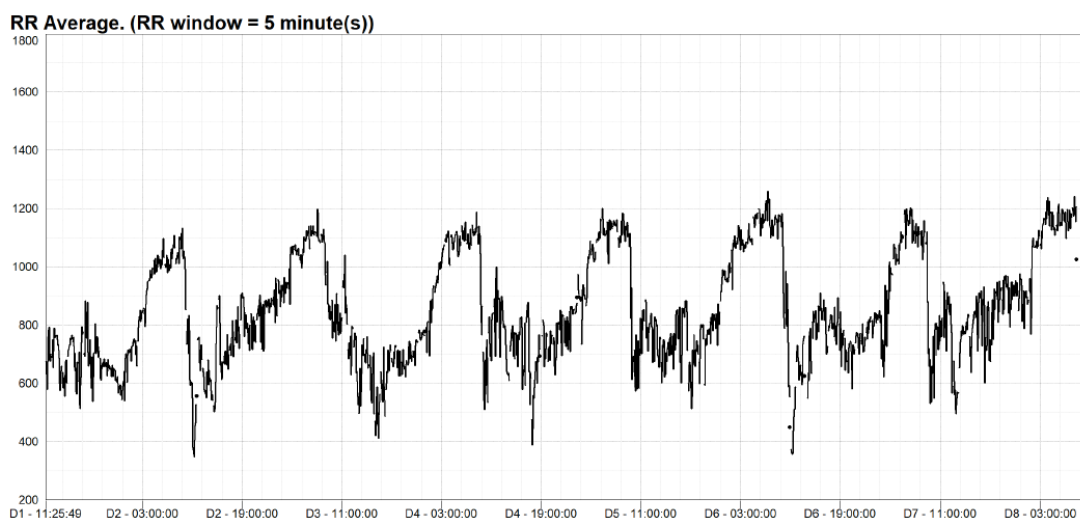


Figure 143 – Example of "RR Average Plot" for Multiday analysis. RR Average, computed over a window of 5 minutes, is visualized in black

3.28. Record Information and Demographics

Selecting "Record Information" or "Record Demographics" from the File menu, it is possible to display information related to the ECG recording.

By selecting the “Record Information” entry, a new dialog (Figure 144) is displayed, reporting:

- Record Information
 - Start date and time of record
 - End date and time of record
 - Sampling rate
 - Amplitude Resolution
 - Number of Leads
 - Lead length, in samples
- Recorder Information
 - Recorder ID
 - Recorder Name
 - Recorder Software
 - Manufacturer
- In case an ISHNE record has been loaded, the full ISHNE header is reported

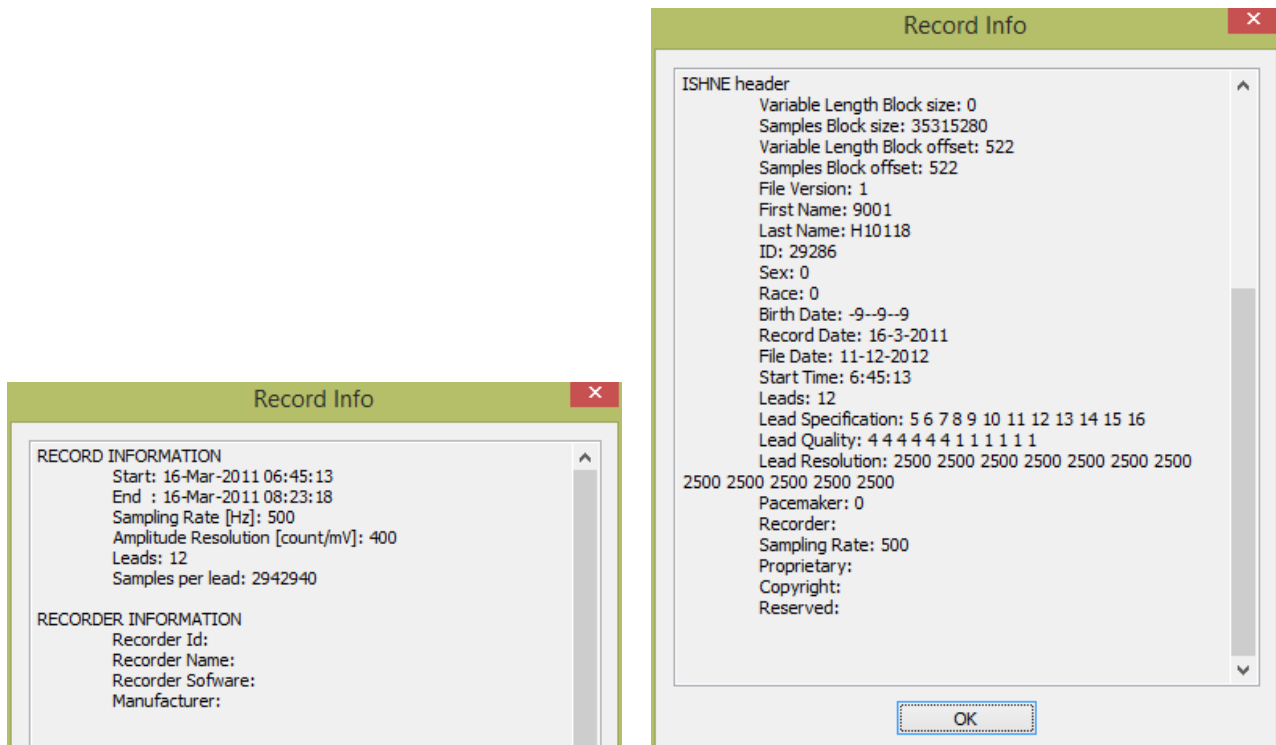



Figure 144 – Record Information details

By selecting the “Record Demographics” entry or clicking the toolbar button , a new dialog with three tabs (Figure 145) is displayed. The dialog reports the following information which can be edited:

- “Subject and Visit” tab
 - Date of Recording
 - Time of Recording
 - Visit ID and related Code System
 - Subject ID, Subject ID Root and Subject Name
 - Date of Birth

- Gender
- Age
- “Clinical Trial” tab
 - Clinical Trial ID and related ID Root
 - Clinical Trial Protocol ID and related ID Root
 - Site ID, Site ID Root and Site Name
 - Investigator ID, Investigator ID Root and Investigator Name
 - Sponsor ID, Sponsor ID Root and Sponsor Name
- “Exam” tab
 - Referred by
 - Treatment
 - Comment (this information is reported on the first page of the report (section 3.27))

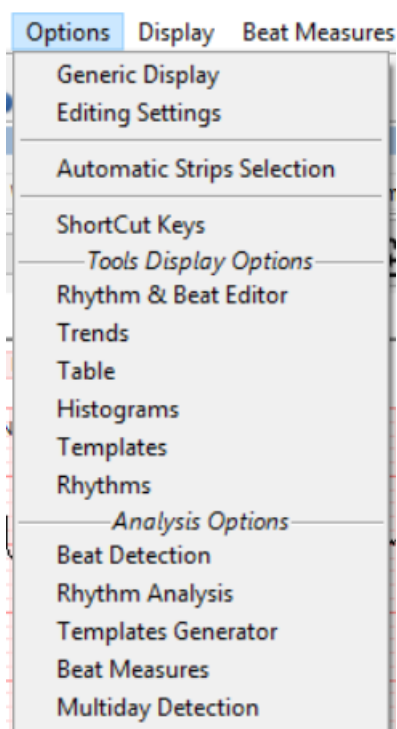
The figure displays three sequential screenshots of the 'Demographics' form, each with a different tab selected. The first screenshot shows the 'Subject and Visit' tab with fields for 'Annotated ECG Fields' (Date Of Rec: 01/01/2001, Time Of Rec: 15:47:40), 'Visit Fields' (ID, Code System), 'Subject Fields' (ID, ID Root, Name: JOBANOVIC, Date Of Birth: 01/01/2002, Sex: Male, Age), and buttons for 'Save & Close' and 'Close'. The second screenshot shows the 'Clinical Trial' tab with fields for 'Trial Fields' (Clinical Trial ID, ID Root, Clinical Trial Protocol ID), 'Site Fields' (ID, ID Root, Name), 'Investigator Fields' (ID, ID Root, Name), and 'Sponsor Fields' (ID, ID Root, Name), with 'Save & Close' and 'Close' buttons at the bottom. The third screenshot shows the 'Exam' tab with fields for 'Exam' (Referred by, Treatment), a 'Comment' section (Total QRS: 117252), and 'Save & Close' and 'Close' buttons at the bottom.

Figure 145 – Demographic Information

Clicking the Close button, editing will be ignored, while by clicking the Save & Close button, all demographic information editing will be saved.

3.29. Options Menu

With this menu it is possible to configure all the available options of the software. These include generic and global option as well as those specific to each module, also accessible from the specific Option button of the module.



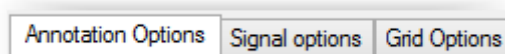
3.29.1. Generic Display Options

The Drawing Options dialog is invoked by selecting "Display Options" after clicking the Options entry of the Menu bar on the top left.

This dialog allows the user to edit several display options but can also modify options on the annotation format.

The Drawing Options dialog is divided into three tabs as described below:

- Annotation Options
- Signal Options
- Grid Options



- Annotation Options

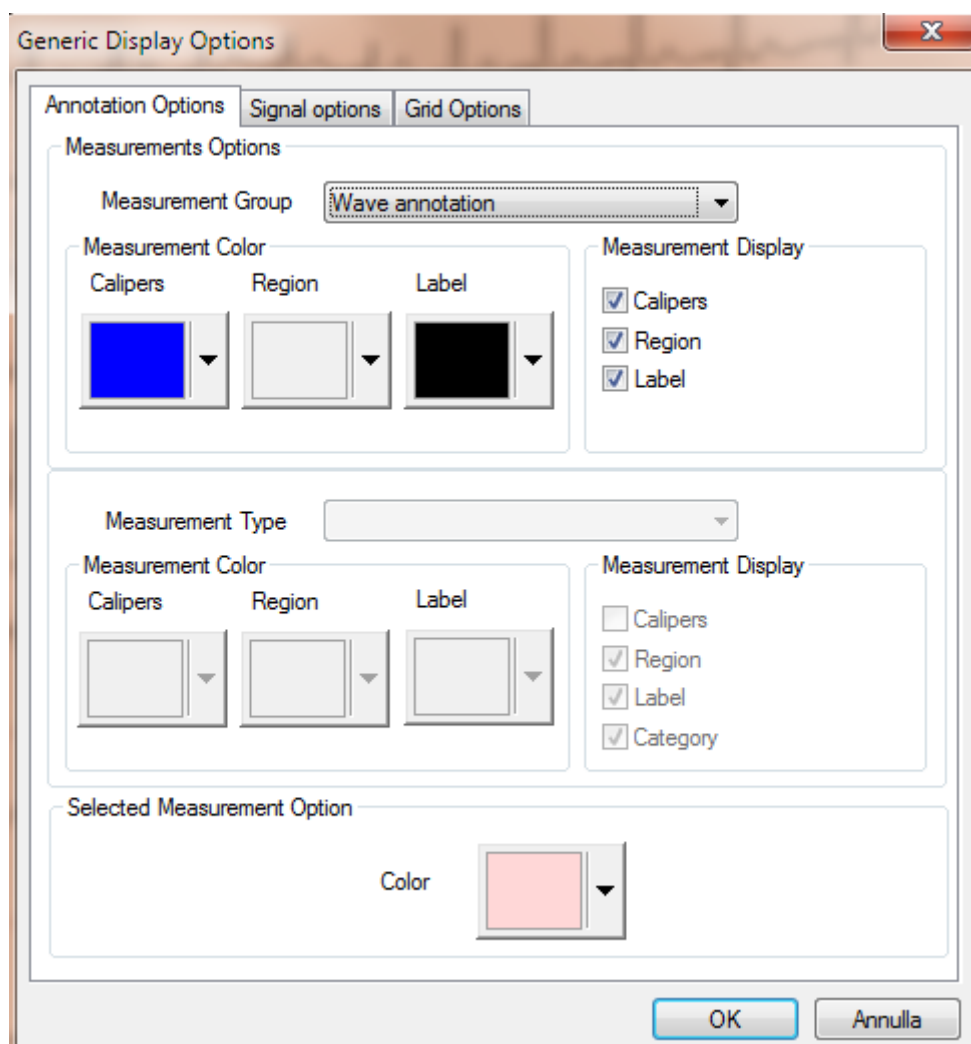
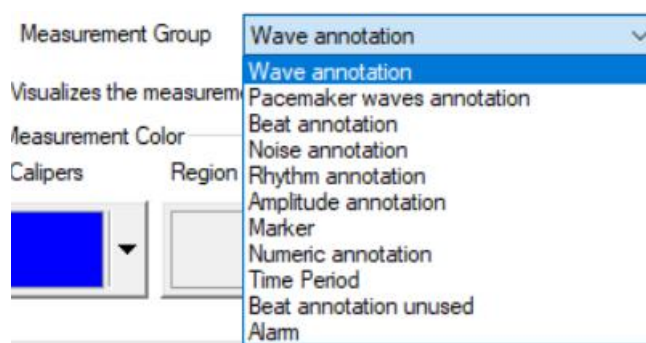


Figure 146 – Drawing Options Dialog, Annotation Options tab

Here different colors can be assigned to the calipers, regions and labels of different annotation types. In the Measurements Display section, the user can decide whether to visualize calipers, region and labels for every displayed annotation (in case of beat annotation which indicates the template's ID of the beat, it is possible to choose whether the category should be displayed or not).

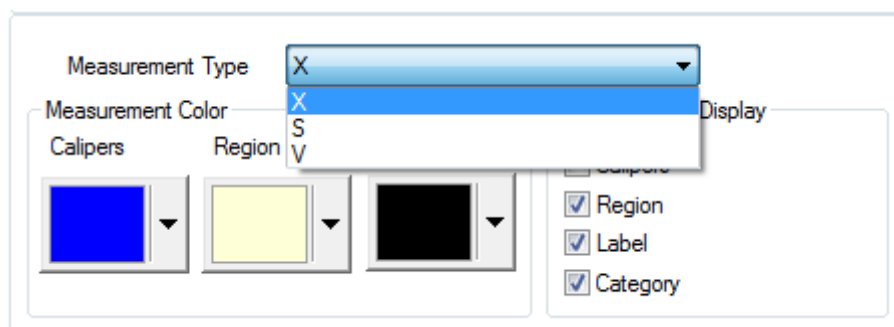
These options can be customized for each group of annotation. The options available are:



- Wave annotation
- Pacemaker waves annotation
- Beat annotation

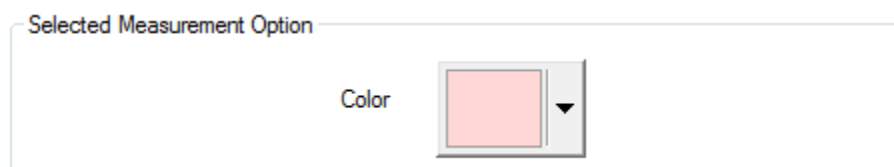
- Noise annotation
- Rhythm annotation
- Amplitude annotation
- Marker
- Numeric annotation
- Time Period
- Beat annotation unused (beat not considered for the analysis, typically the beats under a noise region)

When the Beat annotation group is selected, it is possible to customize the display options for some specific type (X, S and V beats). For all the other beat types, the options of the Beat annotation group are used.



By default, the colors of the label of S and V beats are green and red respectively.

In the Selected Measurement Option, the user can change the color of the area around the currently selected measurements.



- **Signal Options**

In this tab, the user can choose the color and thickness of the ECG tracing. The signal is typically designed continuously, but it can be drawn sample by sample. Finally, the position of the ECG samples can be labeled at selected intervals on the tracings.

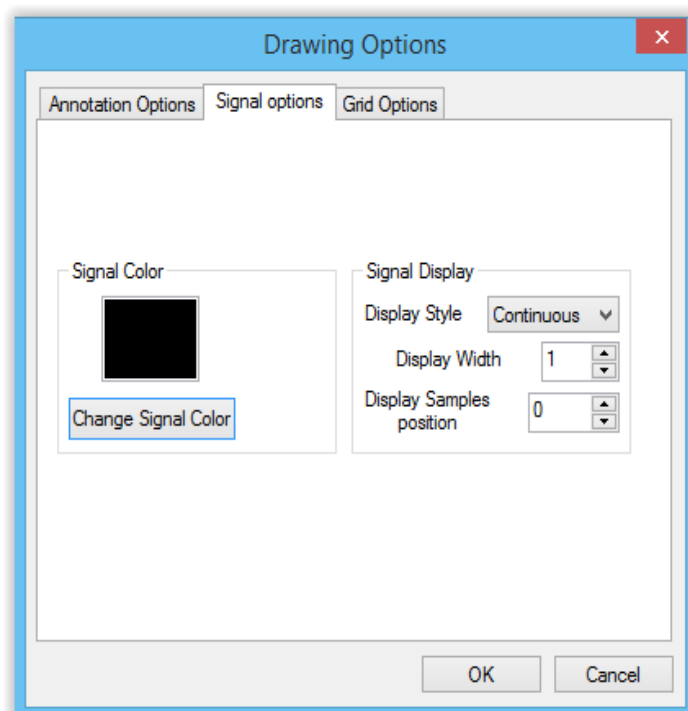


Figure 147 – Drawing Options Dialog, Signal Options tab

- **Grid Options**

The color of the grid can be selected in the Grid Color section.

In this section, it is possible to select display settings to mimic certain layout standards of the paper ECGs, such as:

- Squared grid, paper speed of 25 mm/s and amplitude resolution of 10 mm/mV
- Squared grid, paper speed of 50 mm/s and amplitude resolution of 20 mm/mV
- Squared grid, paper speed of 50 mm/s and amplitude resolution of 10 mm/mV

A fourth custom display setting can be configured by the User.

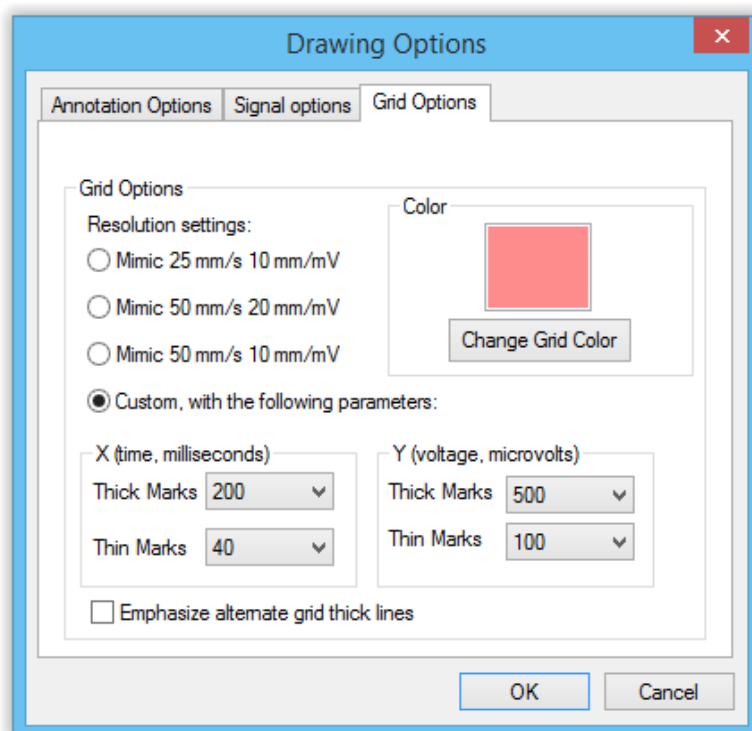


Figure 148 – Drawing Options Dialog, Grid Options tab

Two examples of grids are here shown (Figure 149): the first being custom (X: Thick Marks=100, Thin Marks=20; Y: Thick Marks=500, Thin Marks=100), and the second mimicking a paper speed of 50 mm/s and amplitude resolution of 20 mm/mV.

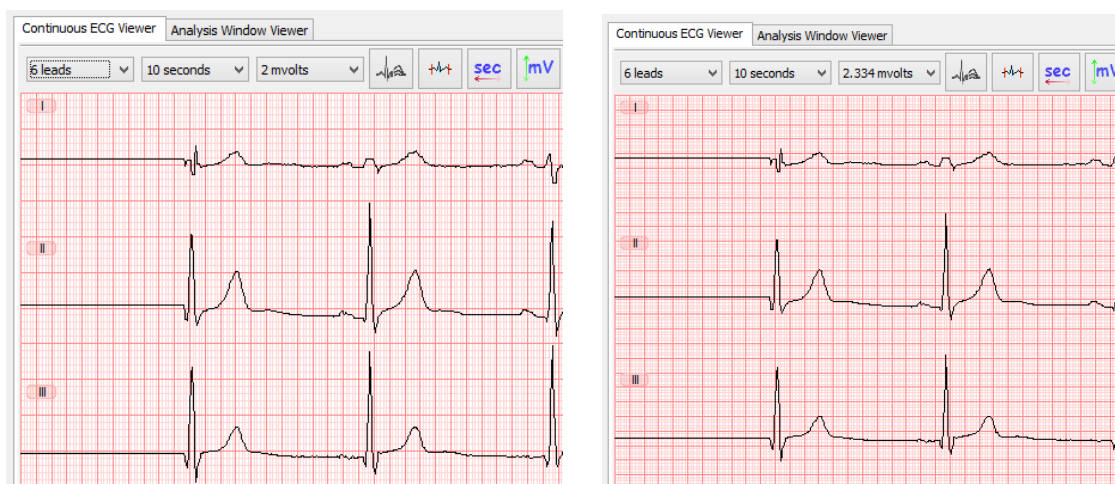


Figure 149 – Two examples (a, b) of ECG grids

3.29.2. Editing Settings

Selecting the "Editing Settings" entry in the Options menu, it is possible to configure the default action to be performed when rhythm annotation events are deleted and the way heart rate is computed, as shown here below.

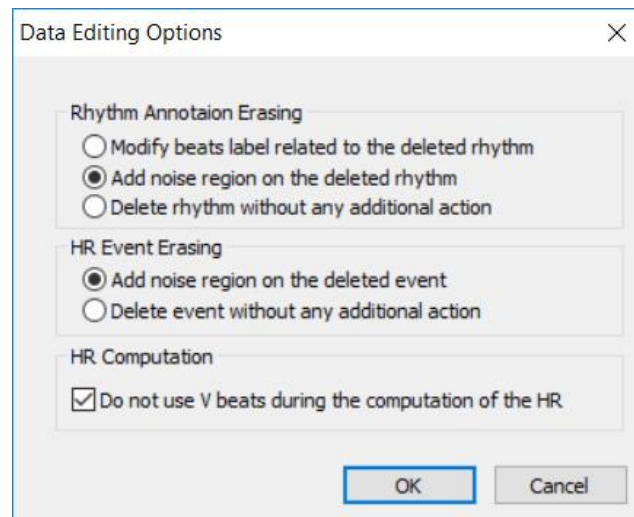


Figure 150 – Rhythm Annotations Editing Settings dialog

With the first check-box it is possible to define the action to be performed when standard rhythm annotation events, those that can only be added automatically by ABILE algorithm (thus excluding Atrial Fibrillation, Atrial Flutter, Atrial Tachycardia, Ventricular Fibrillation, Ventricular Flutter, Torsade de Pointes and Atrioventricular blocks) are deleted.

The default is the second option, where upon the deletion of a standard rhythm annotation event, a noise region, replacing the rhythm annotation will be entered.

With the third option, no action will be performed, only the rhythm annotation will be deleted.

With the first entry by deleting supraventricular and ventricular events (Isolated beat, couplets and runs) the beat labels will be automatically relabeled from S and V to N.

With the second check-box it is possible to define the action to be performed when heart-rate (HR) events are deleted.

The default is the first option, where upon the deletion of an HR event, a noise region, replacing the event will be entered and this shall be the preferred usage.

With the second option, no action will be performed upon deletion of an HR event.

With this latter option, it is very important that HR event review is performed as the very last step of a continuous ECG review, without any other editing, otherwise in case editing is performed after the HR Events editing, inconsistencies between Table and Annotation Summary may be entered.

With the third check-box the user can define the way heart rate is computed every time editing is performed:

- Using all beats available in the 10 s window preceding an ECG beat
- Using only normal beats (N or S) and thus excluding ventricular beats in the 10 s window preceding an ECG beat

In case heart rate of the loaded ECG was computed with a different setting from the current one selected in CER-S, the following message is prompted where the user must select which heart rate computation strategy shall be applied.

The choice may affect the current CER-S setting, in fact by selecting Yes, the way to compute HR will be switched to the one from the loaded recording.

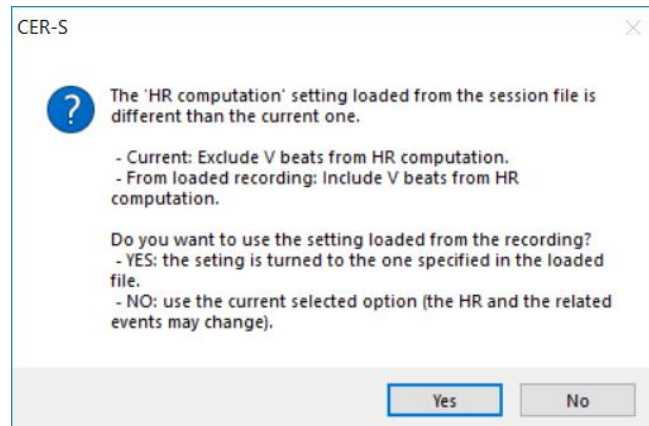


Figure 151 – Rhythm Annotations Editing Settings dialog

3.29.3. Automatic Strips Selection

Here it is possible to configure for which detected rhythm event automatic ECG strips shall be generated, as shown in Figure 152.

The default printable automatic strips are:

- Longest Atrial Fibrillation
- Slowest Bradycardia
- Longest Pause
- Longest Prolonged RR Interval
- Fastest Supraventricular Tachycardia
- Isolated Supraventricular beat having the shortest RR interval
- Shortest Supraventricular Couplet
- Longest SV Run
- Longest SV Bigeminy
- Longest SV Trigeminy
- Longest Atrial Flutter
- Longest Atrial Tachycardia
- Fastest Ventricular Tachycardia
- Isolated Ventricular beat having the shortest RR
- Shortest Ventricular Couplet
- Longest V Run
- Longest V Bigeminy
- Longest V Trigeminy
- Longest Ventricular Fibrillation
- Longest Ventricular Flutter
- Longest Torsade de Pointes

In addition, by selecting the V templates strips it is possible to print one ECG strip for one ECG beat of each of the first six ventricular templates.

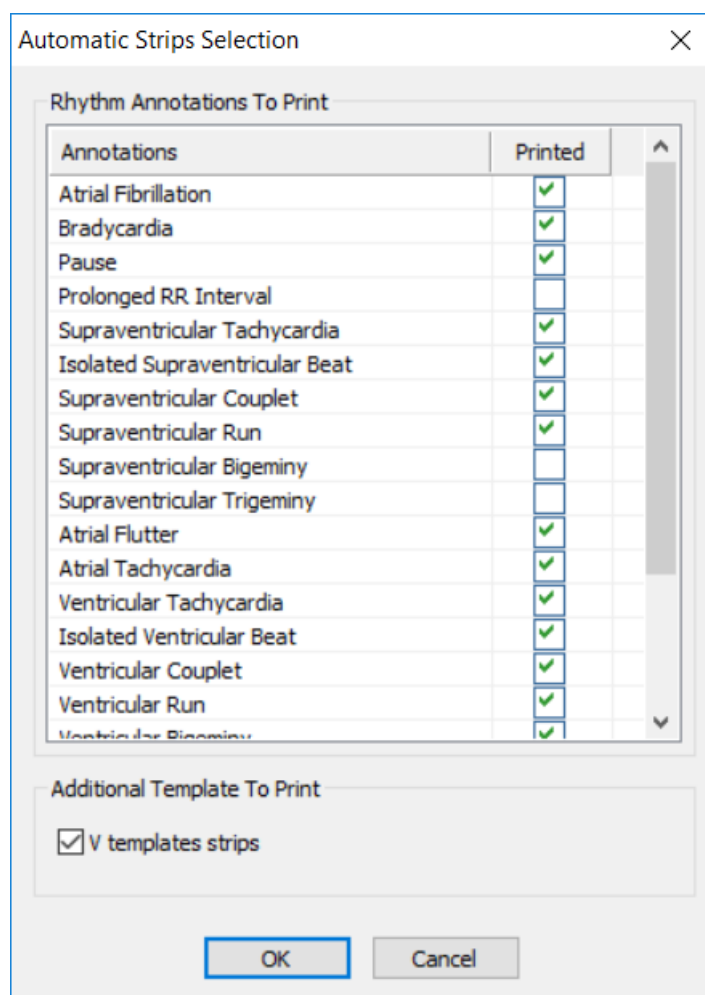


Figure 152 – Automatic Strips Selection dialog

3.29.4. Keyboard Keys Configuration

Selecting the "ShortCut Keys" entry in the Options menu, it is possible to configure the shortcut keyboard keys to be used in the *Continuous ECG Viewer* or *Rhythm & Beat Editor Viewer* and in the *Templates* page and generally in the software.

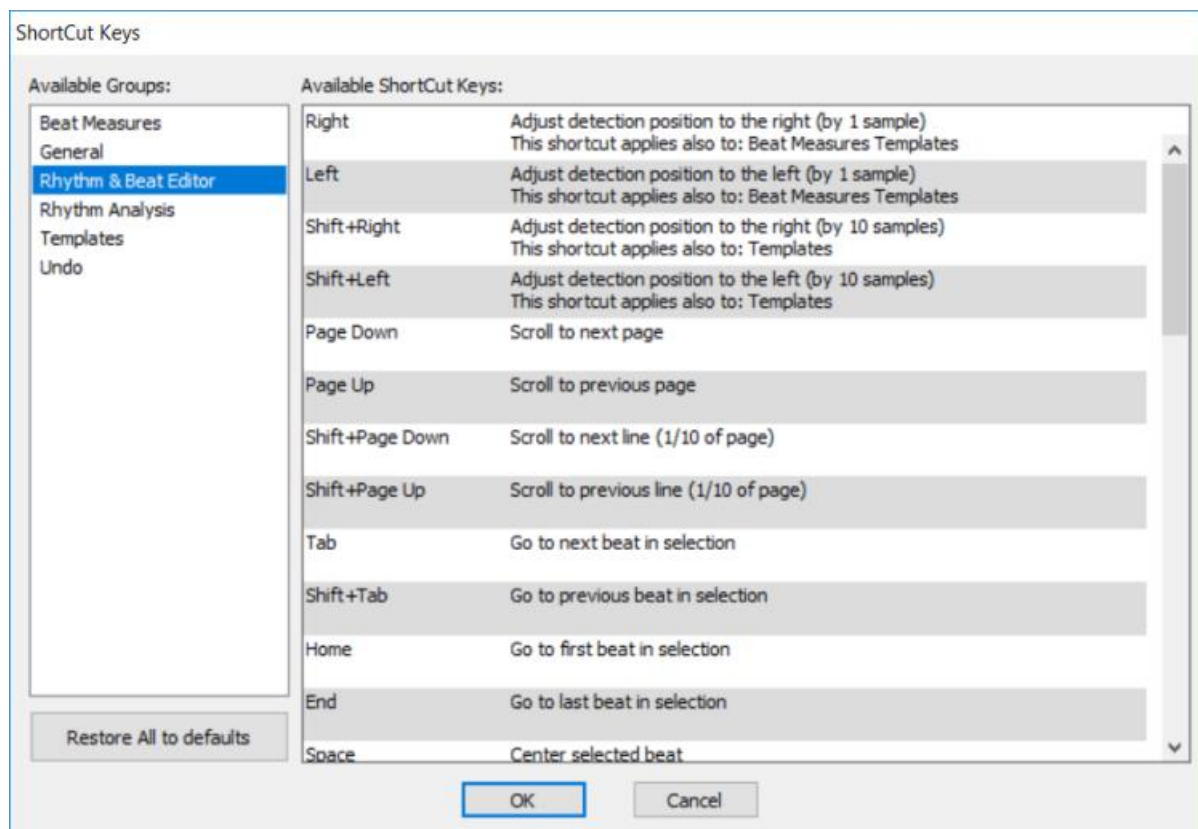


Figure 153 – Short cut keyboard keys configuration

Here is the list of available configurable shortcuts, divided by groups:

Beat Measure

- Move beat detection point to the right (by 1 sample), same as in RBE and Templates
- Move beat detection point to the left (by 1 sample), same as in RBE and Templates
- Move beat detection point to the right (by 10 samples), same as in RBE and Templates
- Move beat detection point to the left (by 10 samples), same as in RBE and Templates

General

- Save Session
- Open Recordings Manager
- Go to previous selected record
- Go to next selected record

Continuous ECG Viewer and Rhythm & Beat Editor

- Scroll to next page
- Scroll to previous page
- Scroll to next line (1/10 of page)
- Scroll to previous line (1/10 of page)
- Go to next item in selection
- Go to previous item in selection

- Go to first item in selection
- Go to last item in selection
- Center selected item
- Select related template
- Select ECG Strip for printing
- Review selected ECG strips for printing

Rhythm & Beat Editor (RBE)

- Go to next beat in time
- Go to previous beat in time
- Add new Unknown beat
- Add new Artefact beat
- Add new Normal beat
- Add new Supraventricular beat
- Add new Ventricular beat
- Add new Calibration Pulse beat
- Add new Bundle Branch Block beat
- Add new Paced beat
- Add new Ventricular Escape beat
- Add new Fusion beat
- Add noise Region
- Delete selected beat or annotation
- Relabel selected beat to Unknown
- Relabel selected beat to Artefact
- Relabel selected beat to Normal
- Relabel selected beat to Supraventricular
- Relabel selected beat to Ventricular
- Relabel selected beat to Calibration Pulse
- Relabel selected beat to Bundle Branch Block
- Relabel selected beat to Paced
- Relabel selected beat to Ventricular Escape
- Relabel selected beat to Fusion
- Adjust beat detection point
- Move beat detection point to the right (by 1 sample), same as in Templates and Beat Measure
- Move beat detection point to the left (by 1 sample), same as in Templates and Beat Measure
- Move beat detection point to the right (by 10 samples), same as in Templates and Beat Measure
- Move beat detection point to the left (by 10 samples), same as in Templates and Beat Measure

Rhythm Analysis

- Run Rhythm Analysis Full (S beats detection + Rhythms)
- Detect S beats only
- Find Rhythms only

Templates

- Merge templates
- Explode template
- Relabel selected template to Unknown
- Relabel selected template to Artefact
- Relabel selected template to Normal
- Relabel selected template to Supraventricular
- Relabel selected template to Calibration Pulse
- Relabel selected template to Bundle Branch Block
- Relabel selected template to Paced
- Relabel selected template to Ventricular
- Relabel selected template to Ventricular Escape
- Relabel selected template to Fusion
- Adjust beat detection point for selected template
- Move beat detection point to the right (by 1 sample), same as in RBE and Beat Measure
- Move beat detection point to the left (by 1 sample), same as in RBE and Beat Measure
- Move beat detection point to the right (by 10 samples), same as in RBE and Beat Measure
- Move beat detection point to the left (by 10 samples), same as in RBE and Beat Measure
- Add noise Region around the ECG beats of the selected template
- Delete beats of the selected template

Undo

Double-clicking the primary mouse button on a given entry allows the user to modify the shortcut. It is also possible to reset short cuts to the default.

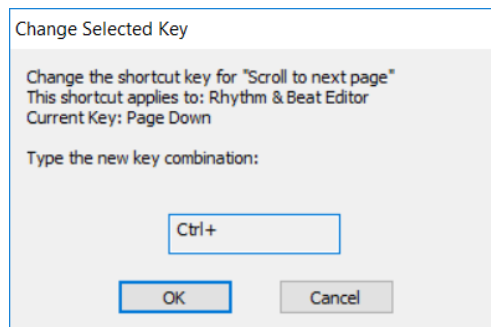


Figure 154 – Change of shortcut keyboard key for "Scroll to next page" entry

3.29.5. Viewer Options

From the "Options" menu is possible to reach the viewer options selecting the corresponding entry which is:

- Continuous ECG Viewer (if available)
- Rhythm & Beat Editor (if available)

For the details of the available options, see section 3.4.10, on page 22.

3.29.6. Navigation Modules Options

From the "Options" menu is possible to reach the options of the navigation modules (if available). The available options are:

- Trends (see section 3.11.2, on page 69)
- Table (see section 3.12.2, on page 78)
- Templates (see section 3.13.3, on page 84)
- Histograms (see section 3.14.1, on page 90)
- Rhythms (see section 3.15.1, on page 96).

3.29.7. Analysis Options

From the "Options" menu is possible to reach the various analysis options:

- Beat Detection (see section 3.20.1.1, on page 113)
- Rhythm Analysis (see section 3.20.2.1, on page 116)
- Multiday Detection (see section 3.20.3.1, on page 119)
- Beat Measures options (see section 3.21.1, on page 122)
- Templates Generator (see section 3.22.1, on page 129)

3.30. About Menu

From this menu, the user can display the About dialog (Figure 155) containing information regarding the version of CER-S and its software components in the Build Info section.

Clicking the "Activate Log" will activate the logging module that gives detailed information for each analysis step (refer to section 3.31 for more details). Clicking on the "Deactivate Log", logging can be disabled.

By clicking the "Plugins" button, a new dialog (Figure 156) showing the details of the loaded plugins is visualized. In case of any problem with the software, please contact AMPS personnel via support@amps-llc.com email and provide all the Build Info. This information can be copied by clicking the "Copy Info" button.

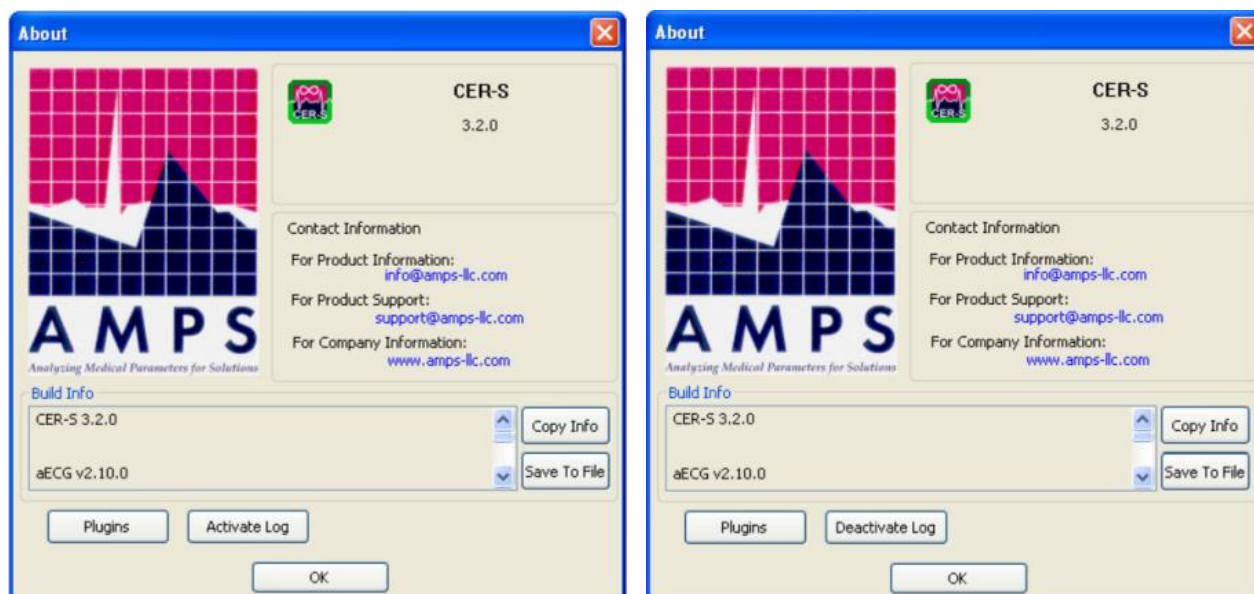


Figure 155 – CER-S About dialog. On the left, the logging has not been activated, while on the dialog on the right side, the logging feature has been enabled

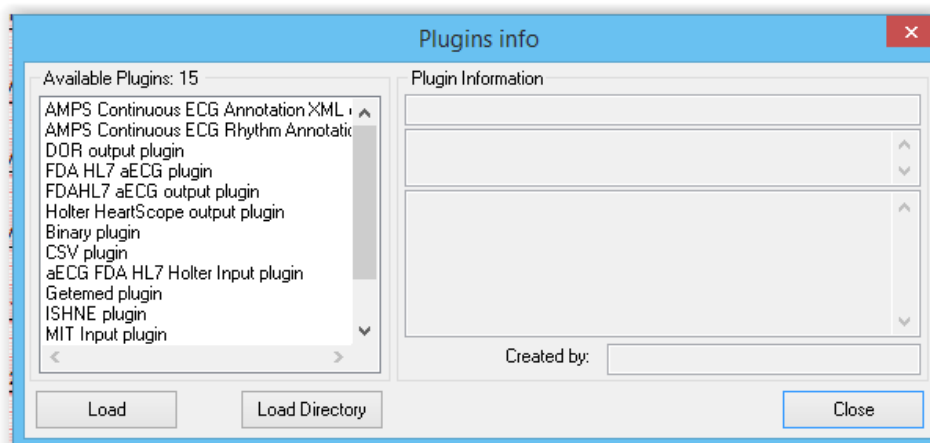


Figure 156 – CER-S About dialog – Loaded Plugins details

3.31. Logging Activation

It is possible to activate the logging of all activities by clicking on the Activate log button from the About menu.

Refer to section 3.30 for more details on the About Menu.

The "Logging.txt" log file gets exported in the folder storing CER-S settings, refer to Section 3.3 of the System Manual for details.

3.32. Command-line usage

Apart from the standalone usage with the graphical interface, it is possible to use CER-S software via its command-line.

This usage is ideal for the "aECG Generation", "Export" "Beat Detection" and "Rhythm Analysis" functions in order to conduct them as a batch process.

Refer to Section 3.1 of the System Manual for all the details.

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