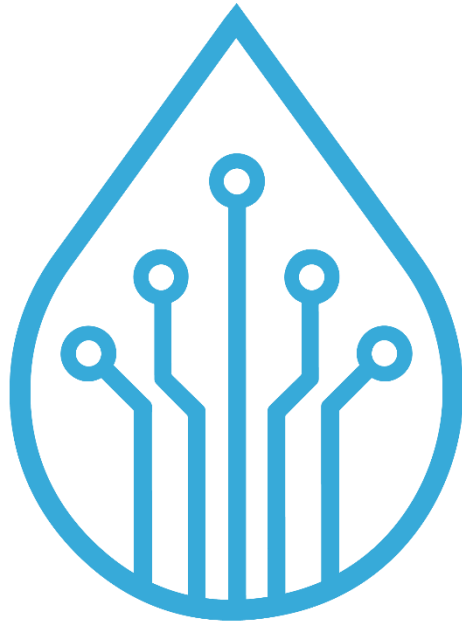


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nanomade

Make All Materials Smart

Nanomade Pulse DevKit

Installation guide, User Interface manual & Test procedure

11/07/2024



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Introduction

Nanomade Pulse is a technology for measuring the vital parameters of a person sitting on a seat or lying on a bed over a period of time. The parameters measured are Inter-Beats Interval (IBI), Breath-to-Breath Interval (BBI) and Actimetry (ACT).

- IBI represents the time interval between two heart patterns. The average value of the IBIs is the Heart Rate (HR), while its variation is the Heart Rate Variability (HRV). IBI is computed every 5s.
- BBI represents the time interval between two breath cycles. The average value of the BBIs is the Breathing Rate (BR), while its variation is the Breathing Rate Variability (BRV). IRI is computed in real time.
- ACT quantifies the subject movements in real time.

You can find all the HRV metrics and norms in the article of F. Shaffer et al. [1]

[1] F. Shaffer et J. P. Ginsberg, « An Overview of Heart Rate Variability Metrics and Norms », *Front. Public Health*, vol. 5, p. 258, sept. 2017, doi: 10.3389/fpubh.2017.00258.

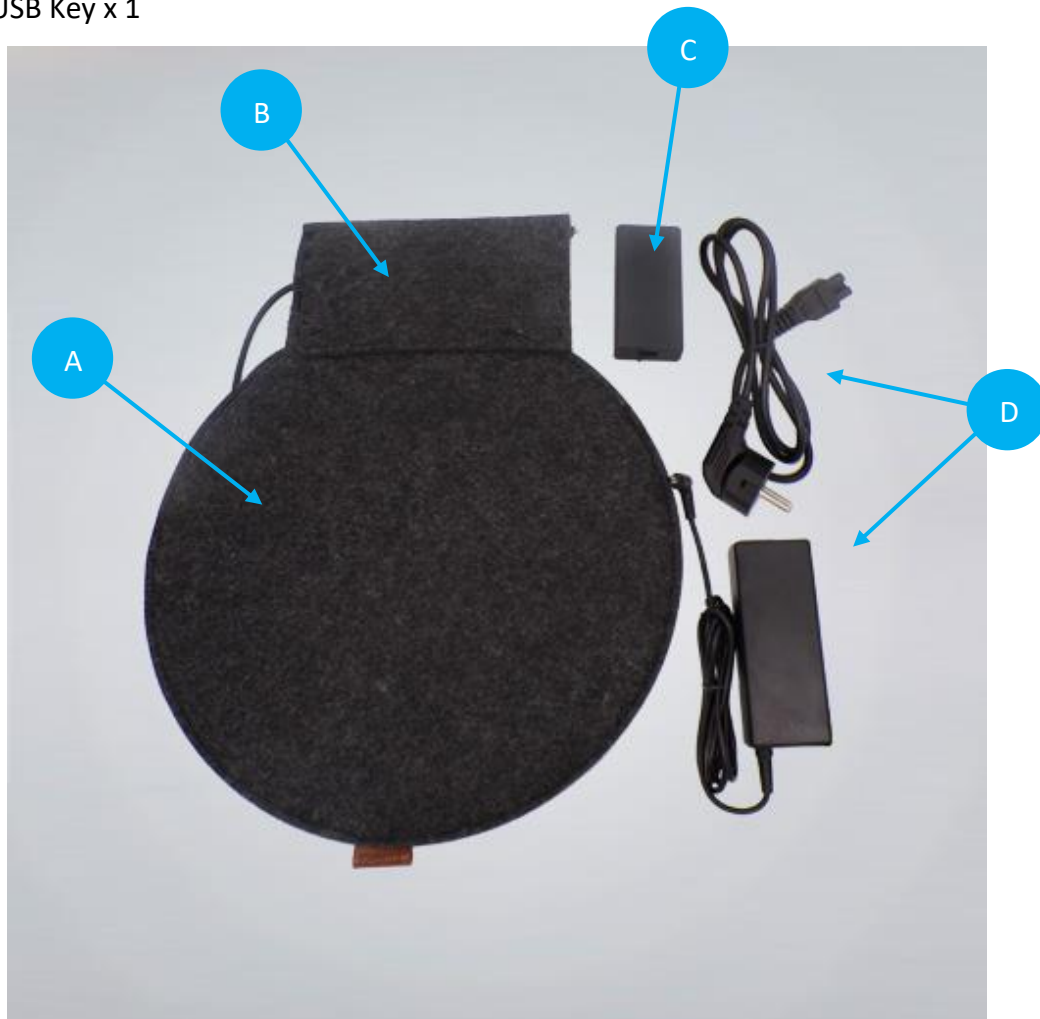


Installation guide

Box contents

Your purchase includes the following items:

- A. Nanomade Pulse Sensor in the cushion cover x 1
- B. Acquisition Board in the pocket x 1
- C. Processing Board with outside BT antenna x 1
- D. Power Cable x 1
- E. USB Key x 1

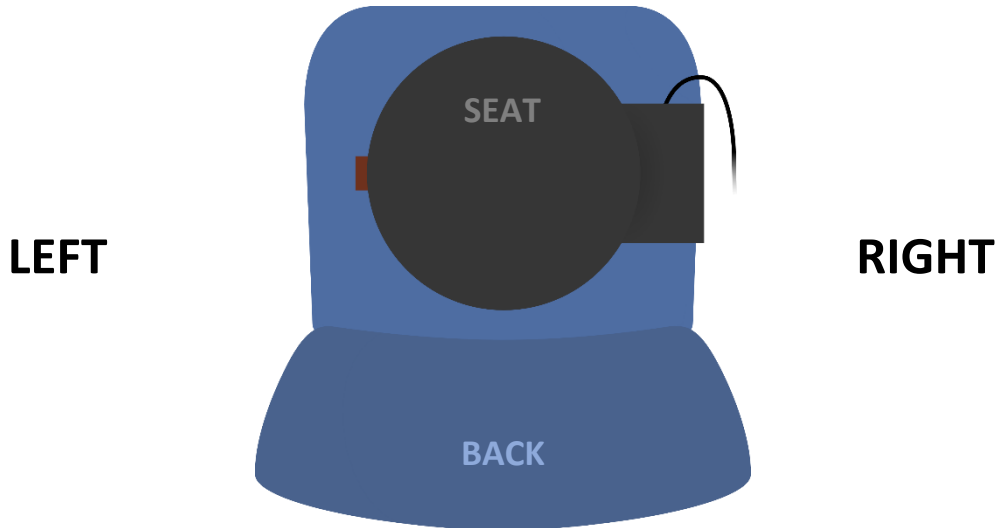


The sensor has previously been placed in the cushion cover and connected to the acquisition board.

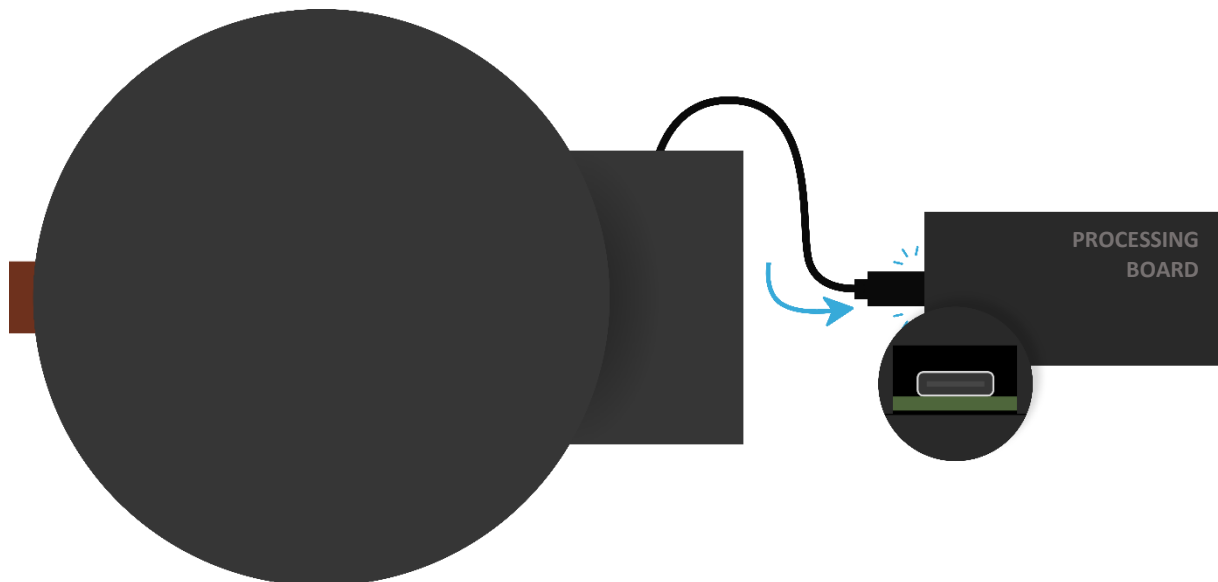


Installation steps

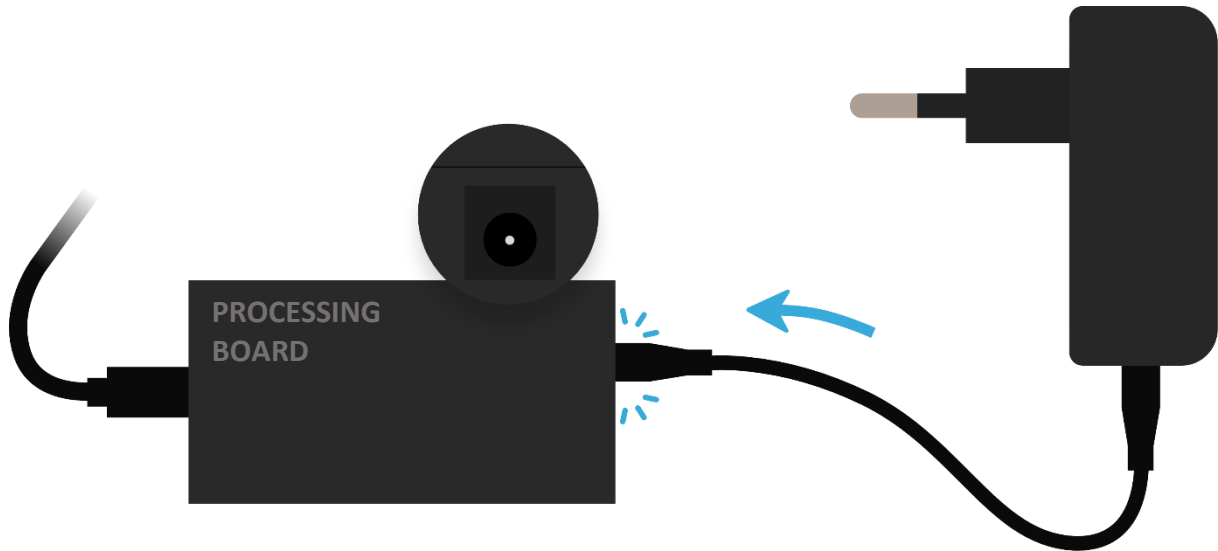
Step 1 : Put the cushion cover on a seat. The pocket on the side of the cover should be on the right-hand side of the seat when installed.



Step 2 : Connect the acquisition board and the processing board by using the USB-C cable to connect the two boards.



Step 3 : Power the processing board. Connect the power cable to the board, then to a power outlet.



The device plug may not be compatible with the local outlet. In this case, use the adapter supplied and connect it before plugging in.

Step 4 : Install the software suite on the Windows 10/11 device from the USB key

Create a new folder in your desktop, then copy/paste all the files contained in the USB key.









Nom	Modifié le	Type	Taille
COMPARISON	18/11/2022 09:39	Dossier de fichiers	
PULSE	18/11/2022 09:39	Dossier de fichiers	
PULSE_MANUAL	18/11/2022 10:32	Foxit PDF Reader ...	657 Ko

- PULSE folder: In this folder you can find the executable to launch the Pulse display.

Qt5RemoteObjects.dll	06/11/2020 10:00	Extension de l'app...	467 Ko
Qt5SerialPort.dll	06/11/2020 09:26	Extension de l'app...	74 Ko
Qt5Svg.dll	06/11/2020 09:27	Extension de l'app...	323 Ko
Qt5Widgets.dll	06/11/2020 06:30	Extension de l'app...	5 370 Ko
<input checked="" type="checkbox"/> UI_WIN_PULSE-DEMO	21/12/2023 11:48	Application	681 Ko

- COMPARISON folder: In this folder you can find the comparison software to compare the pulse and the polar data.



 libstdc++-6.dll	12/05/2018 08:11	Extension de l'app...	1 384 Ko
 libwinpthread-1.dll	12/05/2018 08:11	Extension de l'app...	51 Ko
 opengl32sw.dll	14/06/2016 14:00	Extension de l'app...	20 433 Ko
 Qt5Core.dll	06/11/2020 06:29	Extension de l'app...	5 883 Ko
 Qt5Gui.dll	06/11/2020 06:29	Extension de l'app...	6 844 Ko
 Qt5Svg.dll	06/11/2020 09:27	Extension de l'app...	323 Ko
 Qt5Widgets.dll	06/11/2020 06:30	Extension de l'app...	5 370 Ko
 SYNCHRO_CHART	06/06/2022 18:00	Application	433 Ko

Before launching the Pulse application, make sure you have enabled Bluetooth on your computer/tablet.

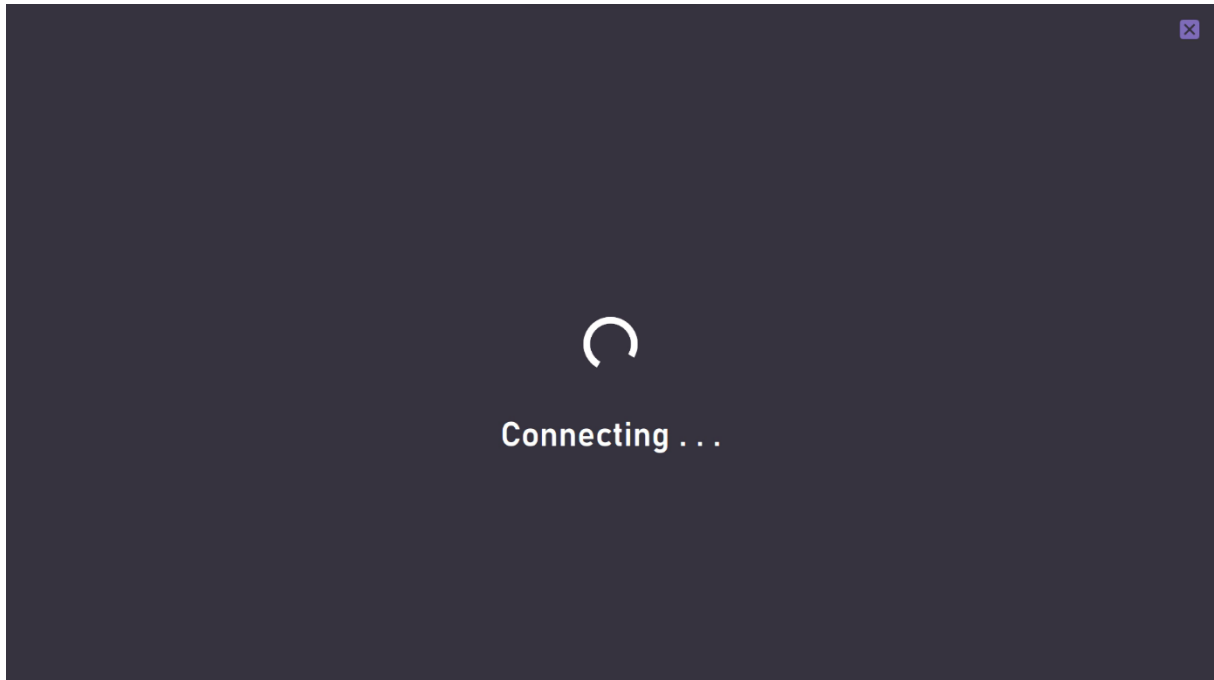
The system is now fully installed and operational.



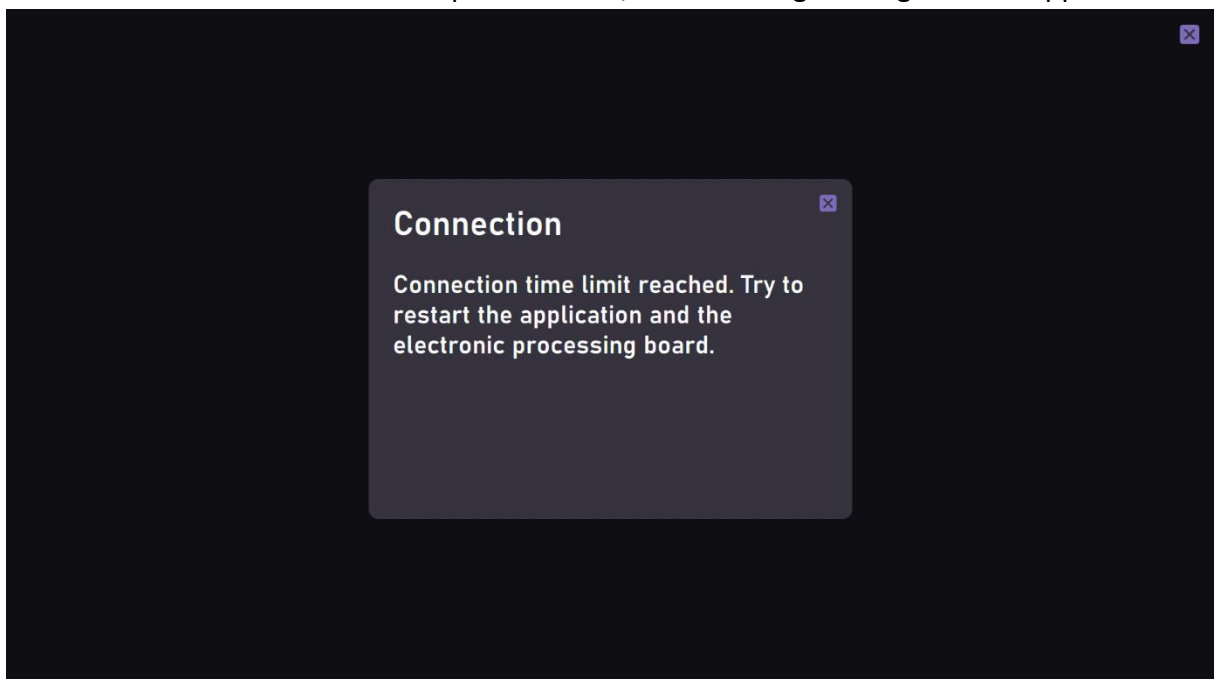
User Interface manual

To start the interface, go to the folder */PULSE* where the application is located and launch the executable (UI_WIN_PULSE-DEMO.exe).

The following window should appear:



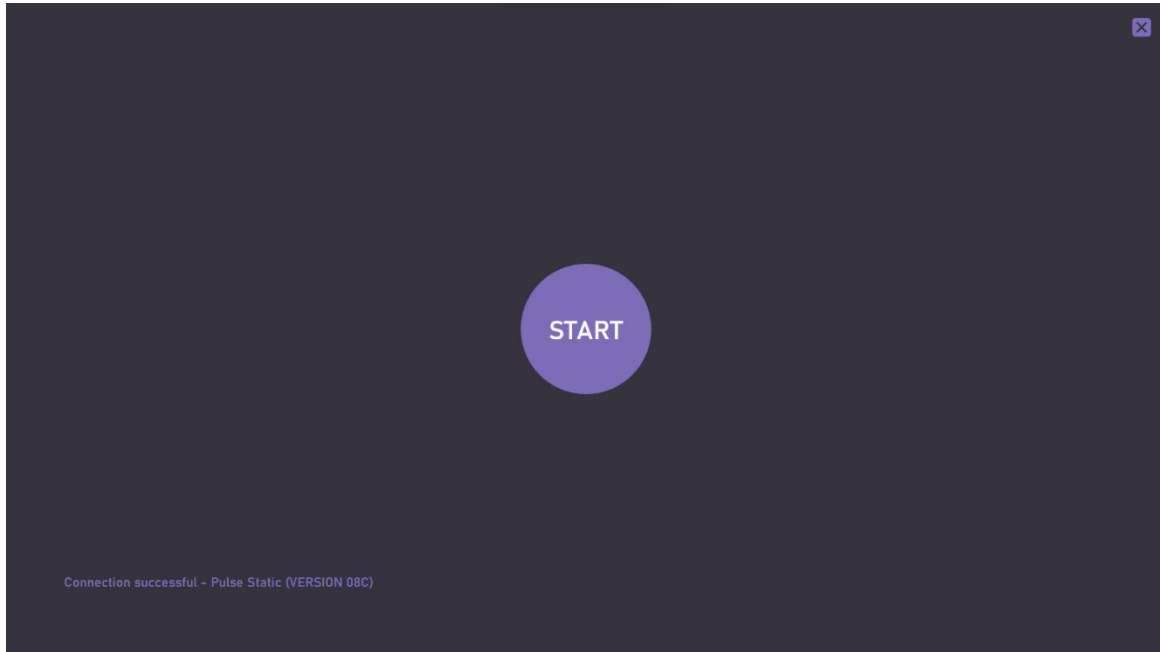
The application is connecting to the processing board via Bluetooth Low Energy. This step can take from 1 to 30 seconds. If the operation fails, the following message should appear :





To correct this problem, close the application. Reboot the processing board by unplugging it, plugging it back in and then restart the application.

If the Bluetooth connection is correctly established. The following window appears :

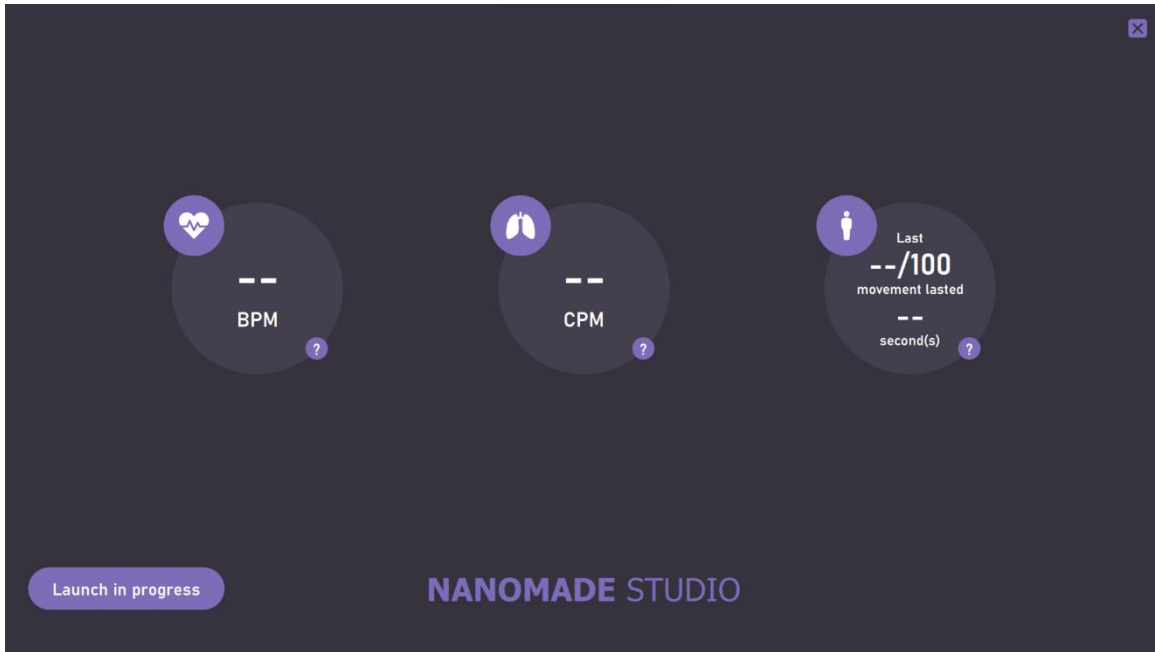


In the bottom left-hand corner of the screen, a message indicates that the connection has been successful, as well as information about the program, such as its version.

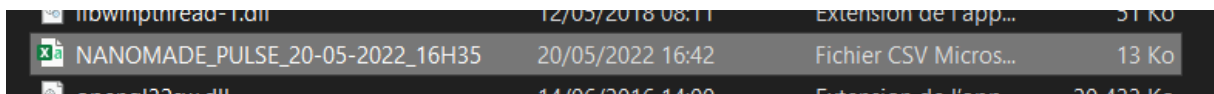
Connection successful - Pulse Static (VERSION 08C)



To launch the measurement session, click on the **START** button. The following menu should appear.

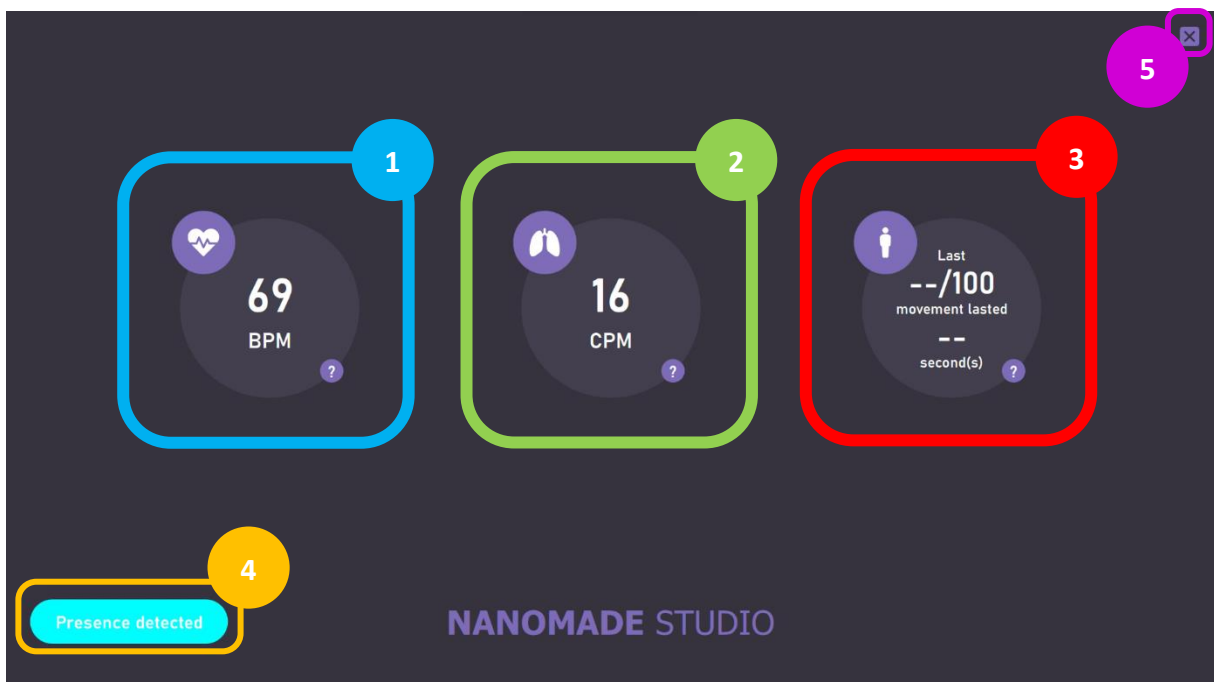


During the session, the software saves all the data in a CSV file. This file is saved in the */PULSE/saves* folder and named with the date and the hour of the start time. Here, an example of such a file:



Data is saved from the moment the start button is pressed until the application is closed.

After few seconds the first data appears on the menu as follow:



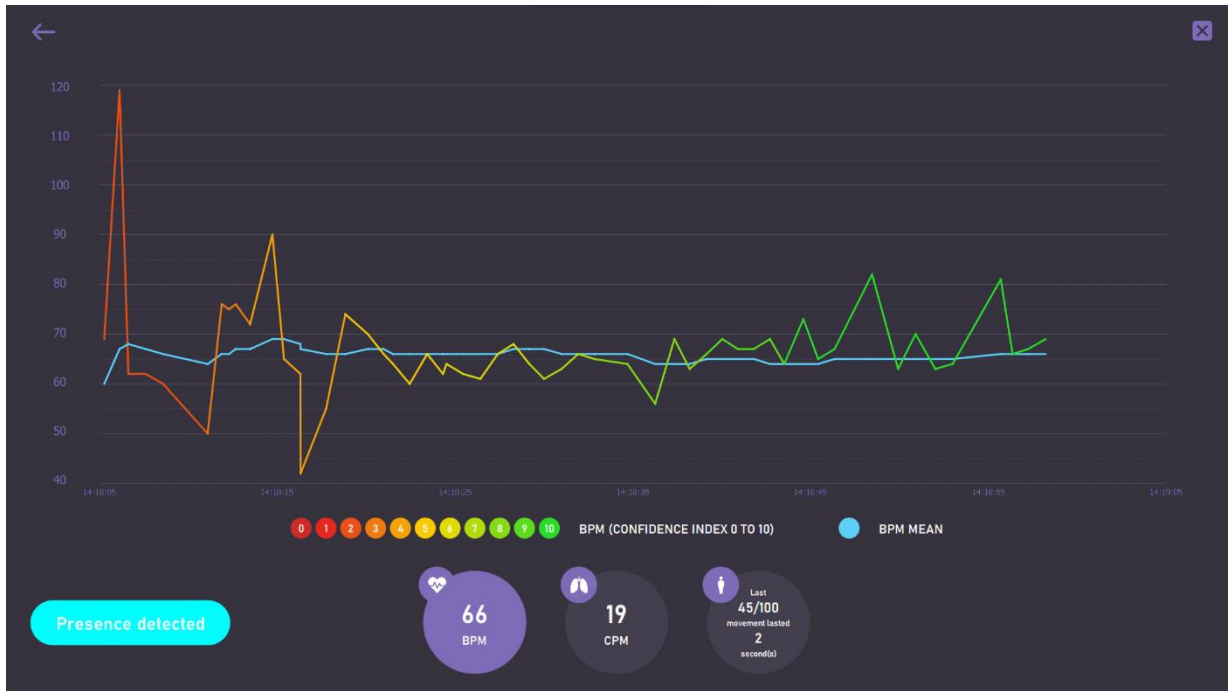


1

Heart Rate

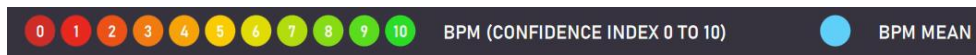
The first bubble on the left indicates the average heart rate recorded by the system over the last 30 seconds in BPM (Beats Per Minute).

When clicking on this bubble, all the value recorded by the system should appear on a graph as the following image.



The graph is made up of two curves. One represents the data recorded and processed by the pulse system, and the other represents the average of these data. The graph displays data received in the last 60 seconds.

As shown in the legend below, the first curve is color-coded from green to red, to reflect the confidence index of the processed data, from 0 to 10.



The higher the confidence index, the more accurate the data.

It is possible to navigate through the graph by dragging it to the left or right. Therefore, you can access to all the HR values recorded through the graph. The data range displayed is always 60 seconds.

Click on the [Live](#) button to return to the last graph data.



2

Breathing Rate

The second bubble indicates the average breathing rate recorded by the system over the last 30 seconds in CPM (Cycles Per Minute).

When clicking on this bubble, all the value recorded by the system should appear on a graph as the following image.



The graph is made up of two curves. One represents the data recorded and processed by the pulse system, and the other represents the average of these data.



It is possible to navigate through the graph by dragging it to the left or right. Therefore, you can access to all the HR values recorded through the graph. The data range displayed is always 60 seconds.

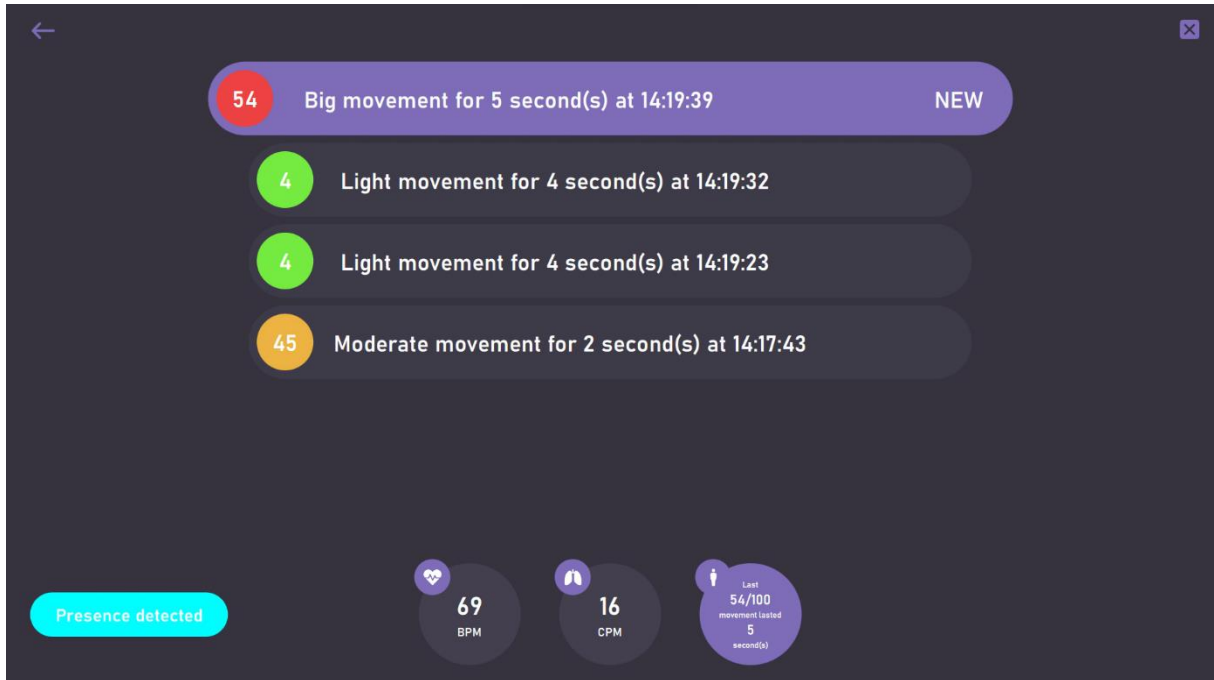
Click on the **Live** button to return to the last graph data.



3 **Actimetry**

The third bubble at the right of the menu indicates the intensity of the last movement recorded as well as the duration of this movement.

When clicking on this bubble, all the value recorded by the system should appear on a list as the following image.



Each movement is associated with a duration, a time and an intensity :

-  **BIG MOVEMENT**
-  **MEDIUM MOVEMENT**
-  **LIGHT MOVEMENT**



4

System status

In the lower right-hand corner of the application is a continuous message indicating the system status in real time. The system can be in 5 different states :

Launch in progress

The system is launching. This state appears at the beginning only.

Presence detected

The system has detected presence and no movement is detected. Measurements of vitals are in progress.

Movement detected

The system has detected movement. This message appears when the person moves. The person must be still in order to resume recording vitals.

Processing in progress

The system has detected the end of the movement and is now processing it. At this stage, the system determines whether or not the person has stood up after a movement. If a new movement is detected during this phase, the system returns to the previous state.

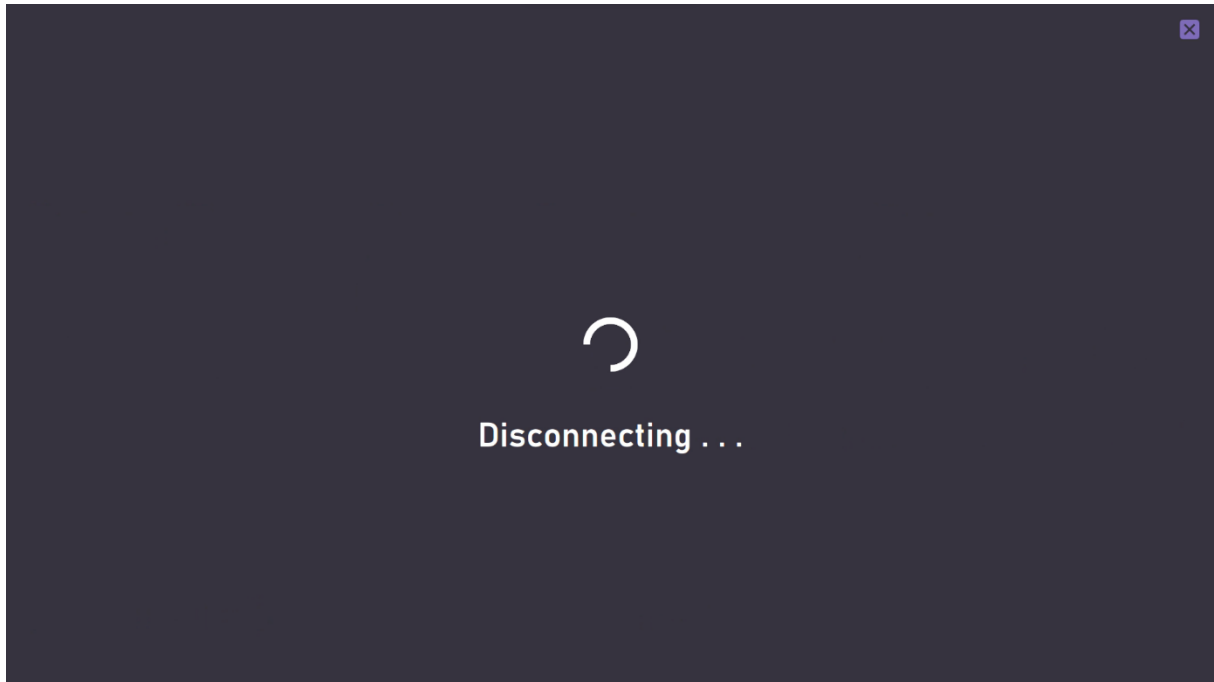
No presence detected

The system does not detect any presence, it is on standby.



5 Close the application

To close the application properly, click on the cross in the top right-hand corner. The next window should appear :

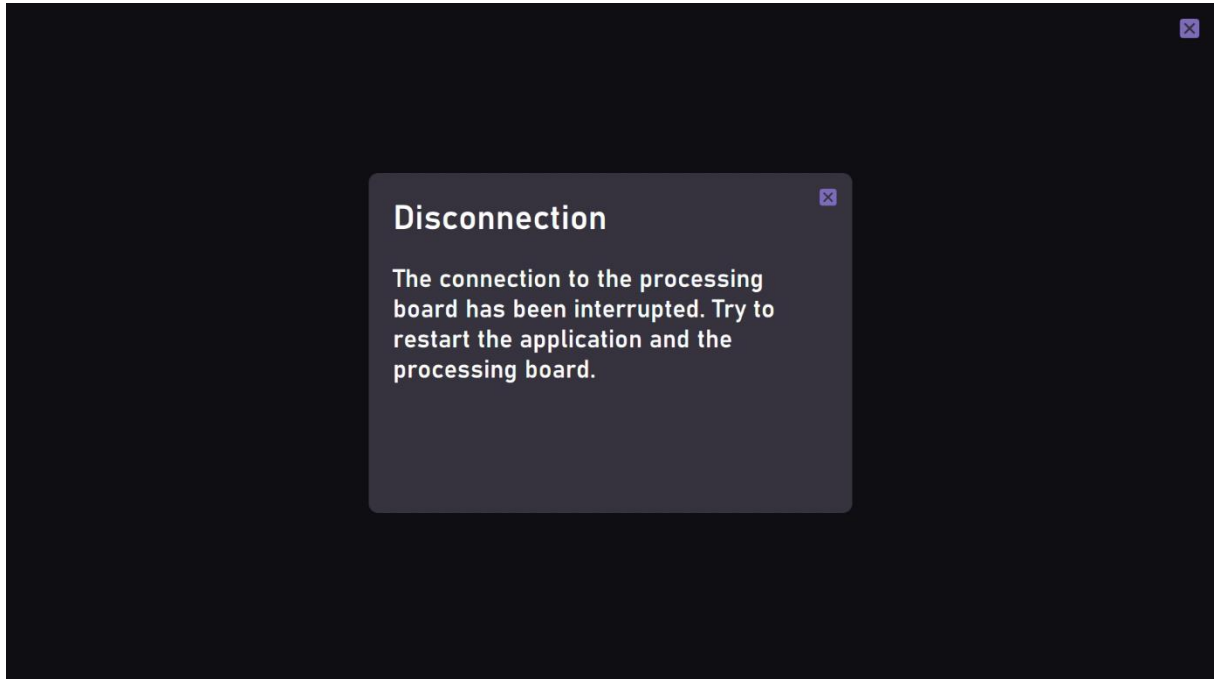


The Bluetooth connection is closed. The operation takes a few seconds, then the application closes.



Bluetooth disconnection error

The Bluetooth connection may be interrupted unexpectedly. In this case, the following error message appears :



To correct this problem, close the application. Reboot the processing board by unplugging it, plugging it back in and then restart the application.



Measurement data file

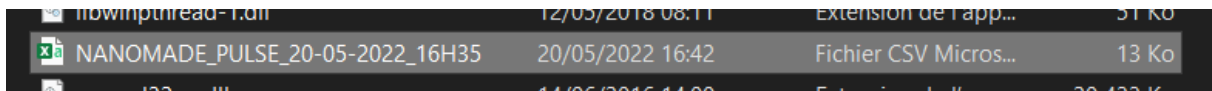
Introduction

Nanomade Pulse technology is composed of an application. This application recovers and display the data measured by the sensors then processed by the AI algorithms. This application has a functionality for saving measured data.

This document explains the format and the particularities of the file created by the application after each recording session.

File recovery

When starting a recording session, a csv file is created:



In the name of the file is indicated the date as well as the hour of the beginning of the session. This file is incremented as the session progresses. It cannot be opened until the session is stopped or the application is closed.

Below, an example of a Nanomade Pulse data file, opened in a text editor:

```
Nanomade STATIC
Timestamp t=0;1653298968752
Type;Time;Timestamp;Value;Unit;Duration (s);Confidence (/10)
IRI;11:43:05.402;1653298985402;14;CPM;;|
IBI;11:42:58.702;1653298978702;69;BPM;1
IBI;11:42:59.562;1653298979562;64;BPM;1
IBI;11:43:00.482;1653298980482;63;BPM;1
IBI;11:43:01.437;1653298981437;66;BPM;1
IBI;11:43:02.357;1653298982357;70;BPM;1
ACT;11:43:09.702;1653298989702;0;/100;1.1;
IRI;11:43:14.652;1653298994652;13;CPM;;
IRI;11:43:22.352;1653299002352;8;CPM;;
IBI;11:43:13.022;1653298993022;70;BPM;1
IBI;11:43:13.887;1653298993887;68;BPM;1
IBI;11:43:14.772;1653298994772;65;BPM;1
IBI;11:43:15.702;1653298995702;64;BPM;1
IBI;11:43:17.497;1653298997497;71;BPM;2
IBI;11:43:18.327;1653298998327;71;BPM;2
IBI;11:43:19.177;1653298999177;67;BPM;2
IBI;11:43:20.072;1653299000072;70;BPM;2
IBI;11:43:20.937;1653299000937;72;BPM;2
ACT;11:43:27.002;1653299097002;1;/100;4.3;
IRI;11:43:48.802;1653299028802;19;CPM;;
IRI;11:43:52.602;1653299032602;15;CPM;;
```



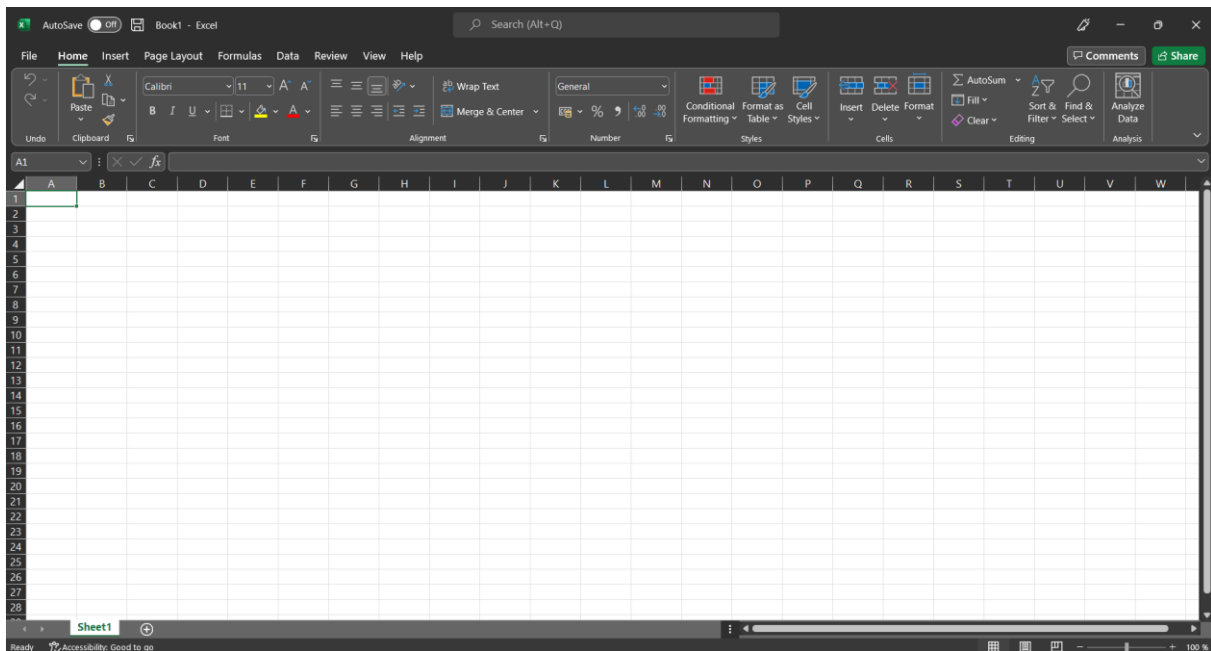
In order to make the file easier to understand, it is preferable to open it in a csv file editor such as Excel.

The default separator used by Excel can be different from one computer to another. Therefore, it is necessary to follow these few steps to open the file correctly. In the rest of the document, we will use Excel.

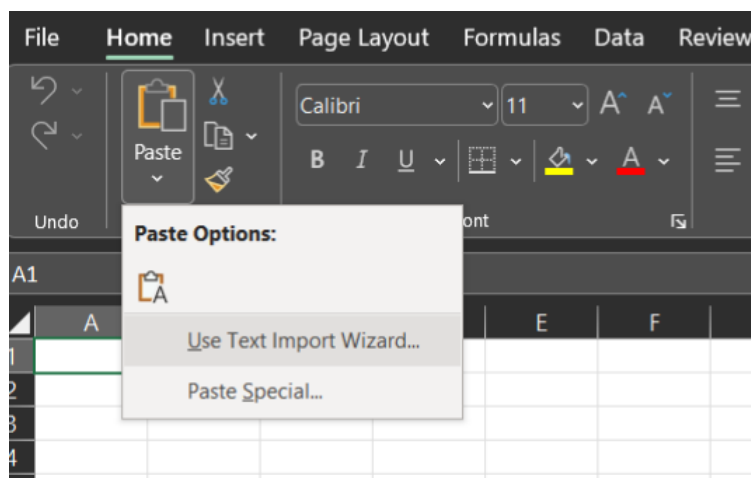
Step 1: Open the Nanomade Pulse data file in a classic text editor such as Notepad on Windows.

Step 2: Copy the content of this file (**Ctrl+A** then **Ctrl+C**)

Step 3: Open **Excel** and select **Blank workbook**:

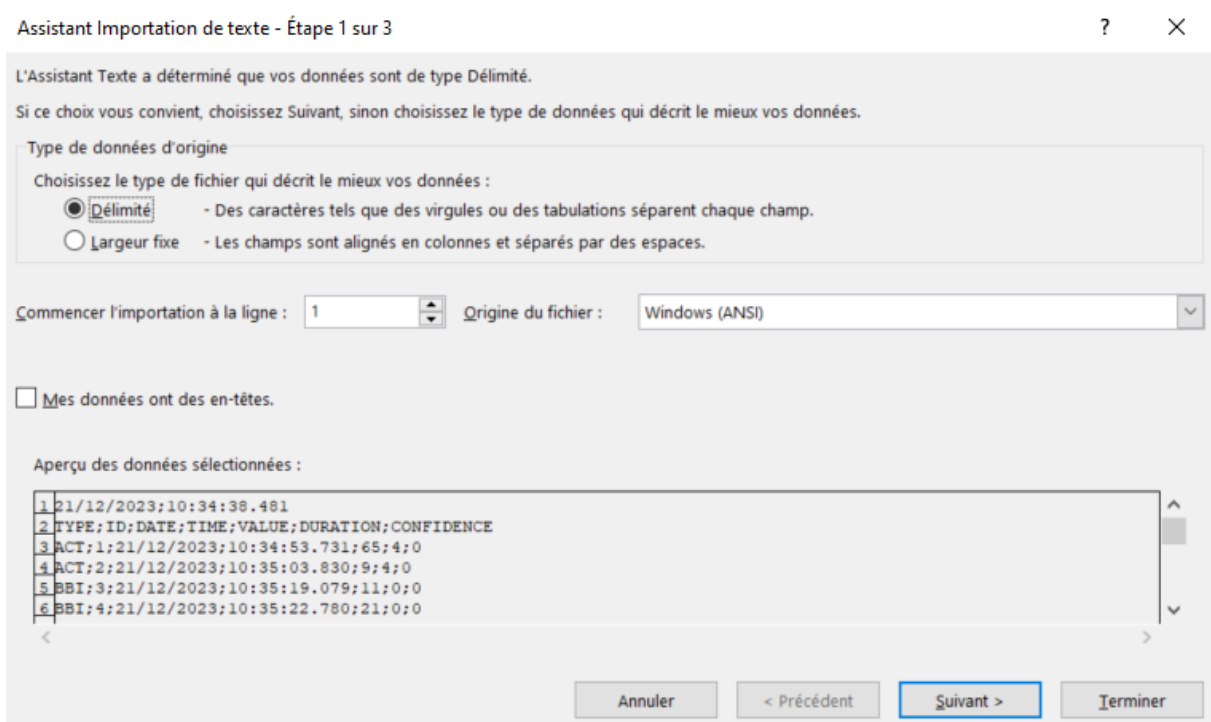


Step 4: Pull down the **Paste** button and select **Use Text Import Wizard**



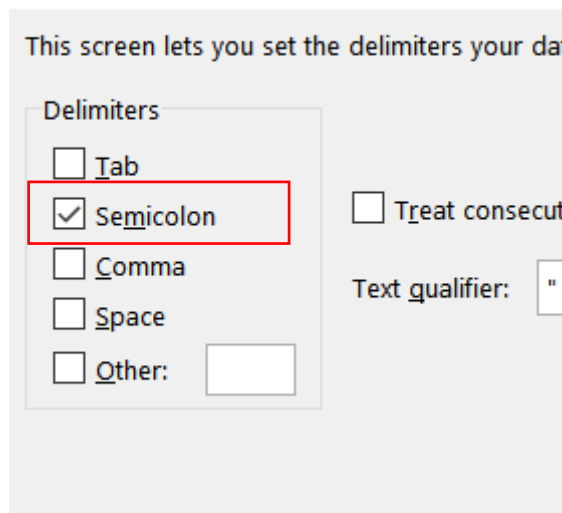


This window appears:

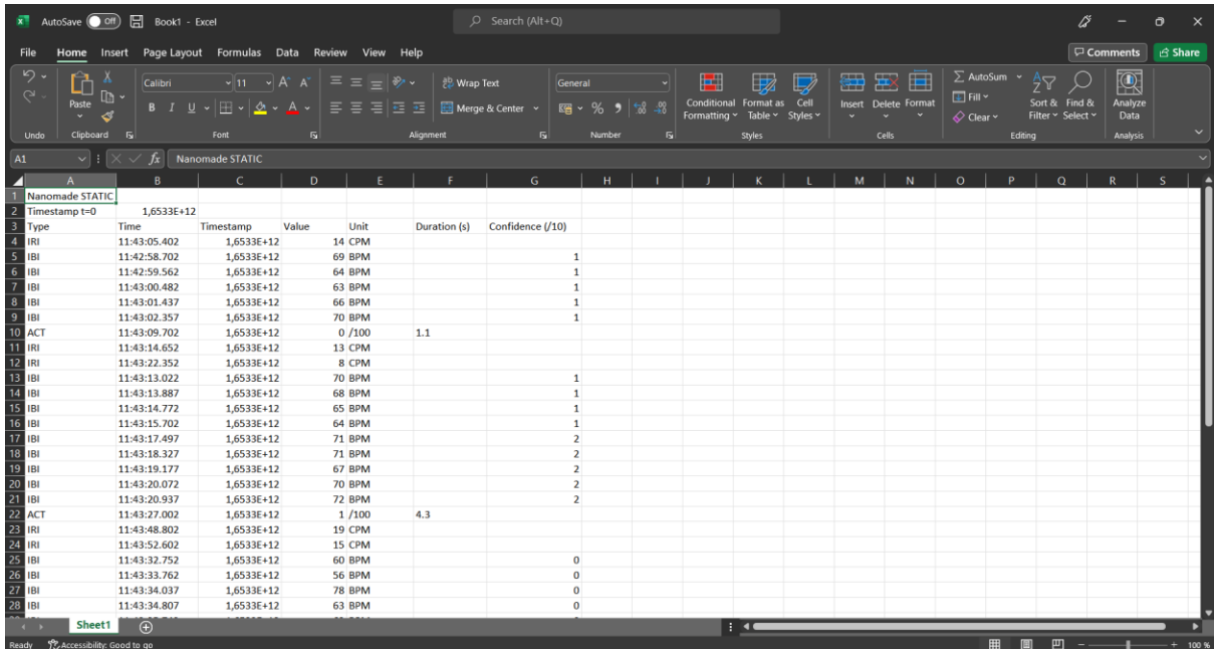


Press **Next** and select **Semicolon** as delimiter:

Text Import Wizard - Step 2 of 3



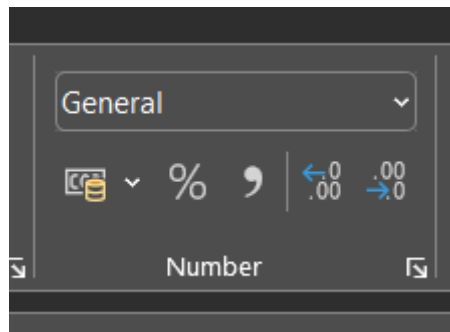
Then press **Finish**. The file should have filled correctly as below:



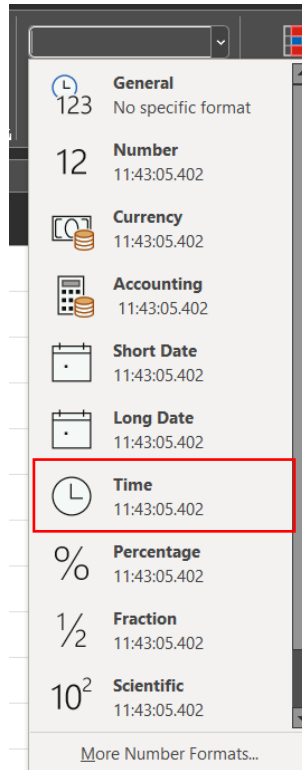
It is possible that the **Time** column is not displayed correctly, as in the example below:

Time
00:34.3
00:37.3
00:40.4
00:43.4
00:49.1
00:35.4
00:36.5
00:36.5

To correct this, go to the Excel ribbon in the **Home** tab then in the **Number** section:



Pull down the **General** dropdown and select **Time**:

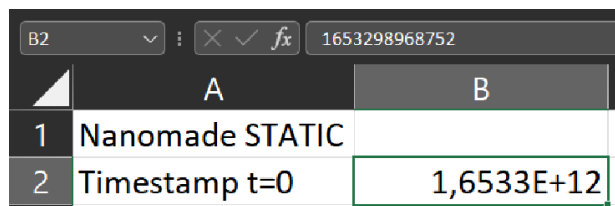


File description

	A	B	C	D	E	F	G
1	Nanomade STATIC						
2	Timestamp t=0	1,6533E+12					
3	Type	Time	Timestamp	Value	Unit	Duration (s)	Confidence (/10)
4	IRI	11:43:05.402	1,6533E+12	14	CPM		
5	IBI	11:42:58.702	1,6533E+12	69	BPM		1
6	IBI	11:42:59.562	1,6533E+12	64	BPM		1
7	IBI	11:43:00.482	1,6533E+12	63	BPM		1
8	IBI	11:43:01.437	1,6533E+12	66	BPM		1
9	IBI	11:43:02.357	1,6533E+12	70	BPM		1
10	ACT	11:43:09.702	1,6533E+12	0	/100	1.1	
11	IRI	11:43:14.652	1,6533E+12	13	CPM		
12	IRI	11:43:22.352	1,6533E+12	8	CPM		
13	IBI	11:43:13.022	1,6533E+12	70	BPM		1
14	IBI	11:43:13.887	1,6533E+12	68	BPM		1

The first line indicate the date and the time of launching.

The second line corresponds to the timestamp of the start of the measurement session.



CONTACT



The next lines constitute a table of the data measured during the recording session.

	A	B	C	D	E	F	G	H	I
1	Nanomade STATIC								
2	Timestamp t=0	1,6533E+12							
3	Type	Time	Timestamp	Value	Unit	Duration (s)	Confidence (/10)		
4	IRI	11:43:05.402	1,6533E+12	14	CPM				IBI
5	IBI	11:42:58.702	1,6533E+12	69	BPM		1		
6	IBI	11:42:59.562	1,6533E+12	64	BPM		1		IRI
7	IBI	11:43:00.482	1,6533E+12	63	BPM		1		
8	IBI	11:43:01.437	1,6533E+12	66	BPM		1		ACT
9	IBI	11:43:02.357	1,6533E+12	70	BPM		1		
10	ACT	11:43:09.702	1,6533E+12	0	/100	1.1			
11	IRI	11:43:14.652	1,6533E+12	13	CPM				
12	IRI	11:43:22.352	1,6533E+12	8	CPM				
13	IBI	11:43:13.022	1,6533E+12	70	BPM		1		
14	IBI	11:43:13.887	1,6533E+12	68	BPM		1		
15	IBI	11:43:14.772	1,6533E+12	65	BPM		1		
16	IBI	11:43:15.702	1,6533E+12	64	BPM		1		
17	IBI	11:43:17.497	1,6533E+12	71	BPM		2		
18	IBI	11:43:18.327	1,6533E+12	71	BPM		2		
19	IBI	11:43:19.177	1,6533E+12	67	BPM		2		
20	IBI	11:43:20.072	1,6533E+12	70	BPM		2		
21	IBI	11:43:20.937	1,6533E+12	72	BPM		2		
22	ACT	11:43:27.002	1,6533E+12	1	/100	4.3			
23	IRI	11:43:48.802	1,6533E+12	19	CPM				

This table is composed of 7 columns:

- **Type** describes the type of the measurement among Inter-Beat Interval (**IBI**), Inter-Respiratory Interval (**IRI**) and l'ACTimetry (**ACT**),
- **Time** is the temporality of the measurement expressed in UTC hour,
- **Timestamps** is the temporality of the measurement expressed in timestamp,
- **Value** is the measured value,
- **Unit** is the unit of the measured value. It is expressed in Beats Per Minute (**BPM**) for the IBI, in Cycles Per Minute (**CPM**) for the IRI and quantified **out of 100** for the ACT,
- **Duration** is the duration in second(s) of a measured movement, associated with an **ACT** measurement,
- **Confidence** is the confidence attributed to a measure of **IBI**. This confidence level is between 1 and 10 with 10 being the most accurate.



Test procedure

Introduction

This part explains the process of comparing data measured by Nanomade Pulse technology and reference value established at the very same time by a Polar product (HRV accuracy performance measurement).

The Polar reference used in this document is the Polar H10. In order to manage the Polar data, it is necessary to install the Elite HRV application available on App Store and Google Play.

The software SOFTWARE_CHART.exe located in the *PULSE* folder, enables comparison between the Nanomade Pulse and the Polar data.

Steps: Polar and Pulse comparison

Step 1: Nanomade Pulse Technology installation

To complete this step, refer to the Pulse installation manual in part I.

Step 2: Polar H10 setup

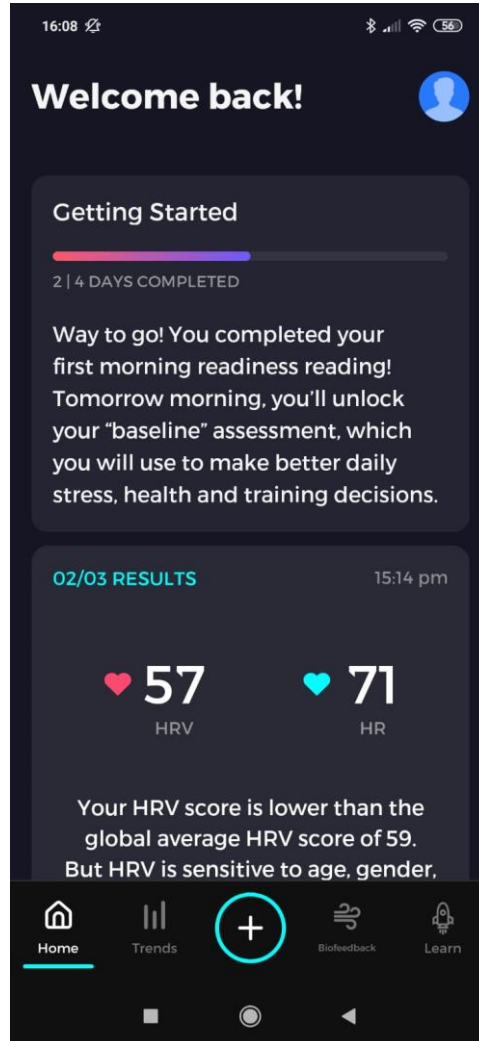
To complete this step, refer to Polar H10 manual available on:

https://support.polar.com/e_manuals/h10-heart-rate-sensor/polar-h10-user-manual-english/manual.pdf.

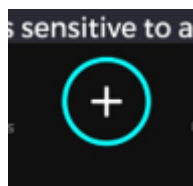
Step 3: Polar H10 and Elite HRV pairing

Once the subject wears the Polar H10, the Polar can be paired with the Elite HRV app.

When launching Elite HRV for the first time, it is necessary to create an account to access the rest of the application. Once logged, the following menu should appear:

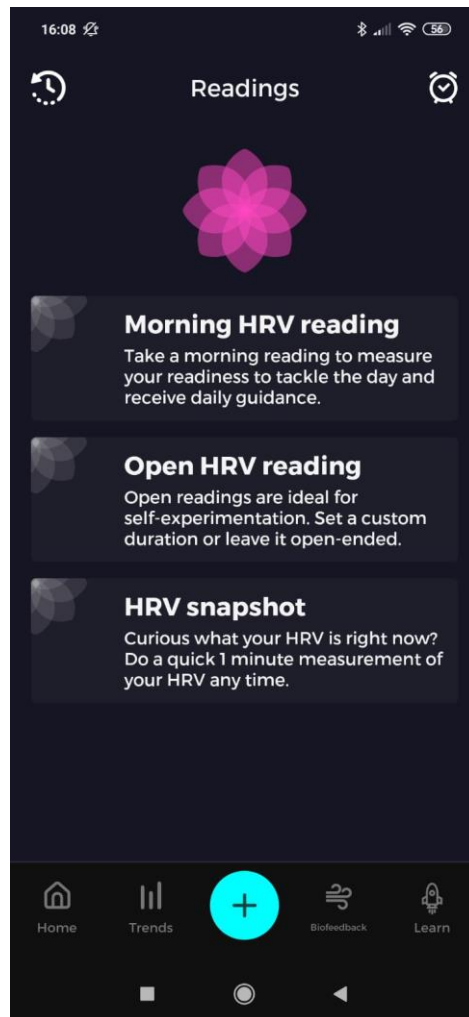


To launch a measuring session, press the + button at the bottom of the menu:

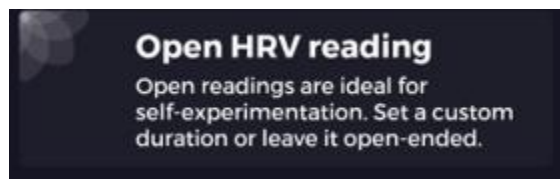




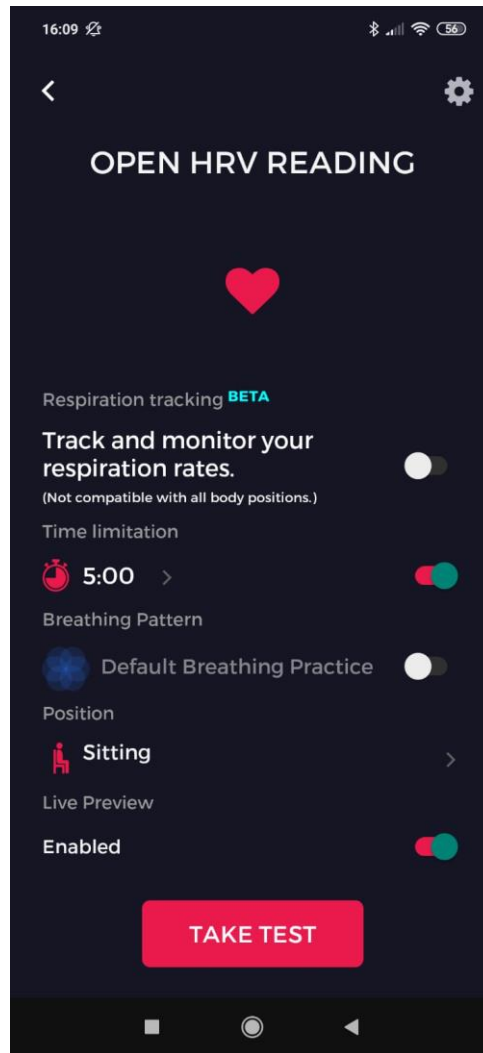
Now, the following menu should appear:



Press **Open HRV reading**:



The following parameters menu appears:



The session duration is adjustable by modify the **Time limitation**:



Once all the settings have been set, press the **Take test** button:

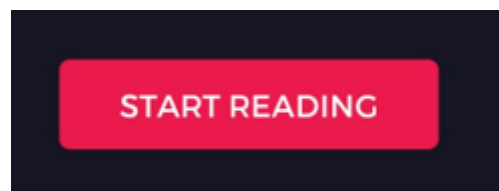
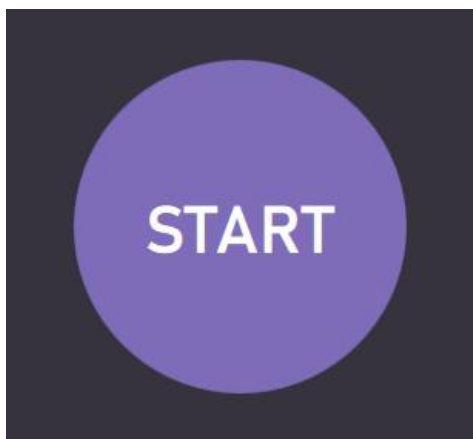


The application should detect and connect automatically to the Polar H10. The following menu appears:



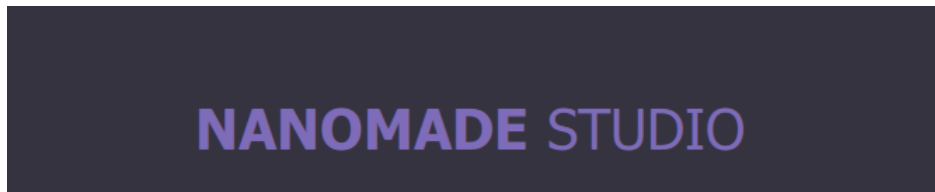
Step 4: Nanomade Pulse and Polar synchronization

To sync Nanomade Pulse and Polar before a measuring session, when launching the session, press the **Start** button of the Nanomade Pulse interface (left) and the **Start Reading** button of Elite HRV app (right) at the same time.

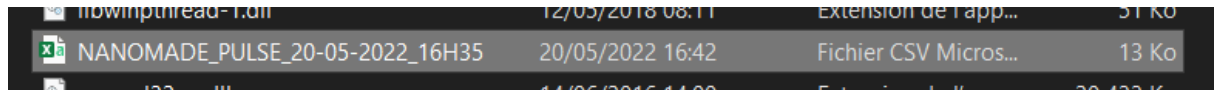


Step 5: Nanomade Pulse data recovery

To finish the sampling session, press the **Nanomade STUDIO** button on the Nanomade Pulse interface:



Go to the folder where you launch the Pulse application (UI_WIN_PULSE-DEMO.exe). A new csv file should have been created:



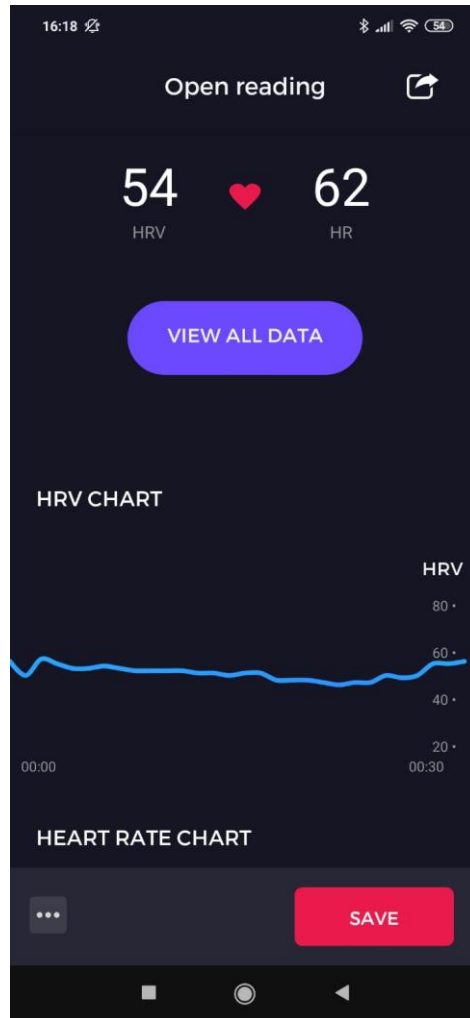
This file contains all the data measured by Nanomade Pulse. Below is an example of the contents of such file:

Nanomade STATIC						
Timestamp t=0	1,6531E+12					
Type	Time	Timestamp	Value	Unit	Duration (s)	Confidence (/10)
IRI	16:36:07.292	1,6531E+12	17	CPM		
IRI	16:36:11.142	1,6531E+12	15	CPM		
IBI	16:36:04.347	1,6531E+12	58	BPM		1
IBI	16:36:05.367	1,6531E+12	58	BPM		1
IBI	16:36:06.387	1,6531E+12	58	BPM		1
IRI	16:36:14.892	1,6531E+12	16	CPM		
IBI	16:36:07.412	1,6531E+12	62	BPM		2
IBI	16:36:08.387	1,6531E+12	63	BPM		2
IBI	16:36:09.347	1,6531E+12	60	BPM		2
IBI	16:36:10.352	1,6531E+12	58	BPM		2
IRI	16:36:18.742	1,6531E+12	16	CPM		
IRI	16:36:23.042	1,6531E+12	15	CPM		
IBI	16:36:12.482	1,6531E+12	63	BPM		3
IBI	16:36:13.447	1,6531E+12	60	BPM		3
IBI	16:36:14.442	1,6531E+12	61	BPM		3
IBI	16:36:15.427	1,6531E+12	64	BPM		3
IRI	16:36:27.442	1,6531E+12	14	CPM		
IBI	16:36:17.227	1,6531E+12	59	BPM		4
IBI	16:36:18.242	1,6531E+12	59	BPM		4
IBI	16:36:19.267	1,6531E+12	62	BPM		4
IBI	16:36:20.227	1,6531E+12	62	BPM		4
IBI	16:36:21.192	1,6531E+12	58	BPM		4
IRI	16:36:31.442	1,6531E+12	16	CPM		

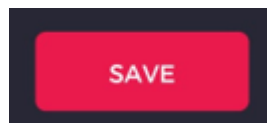


Step 6: Polar data recovery

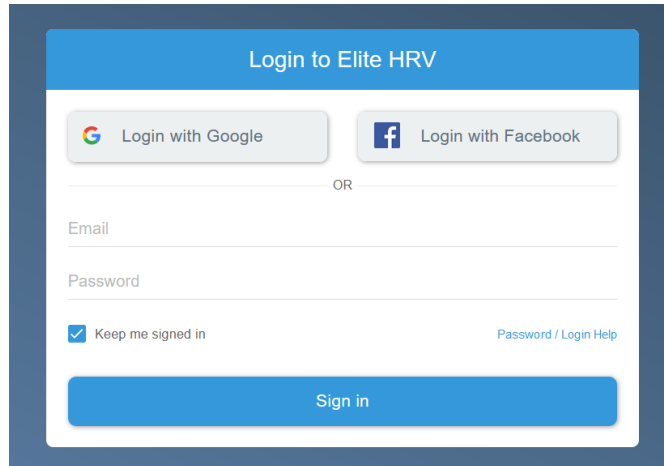
Once the session is ended, the following menu appears on the Elite HRV app:



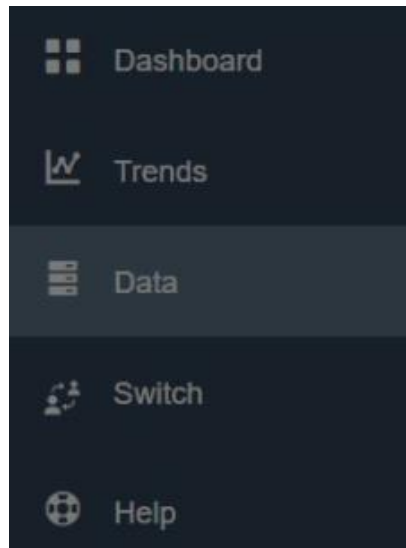
To save the data, press the **Save** button:



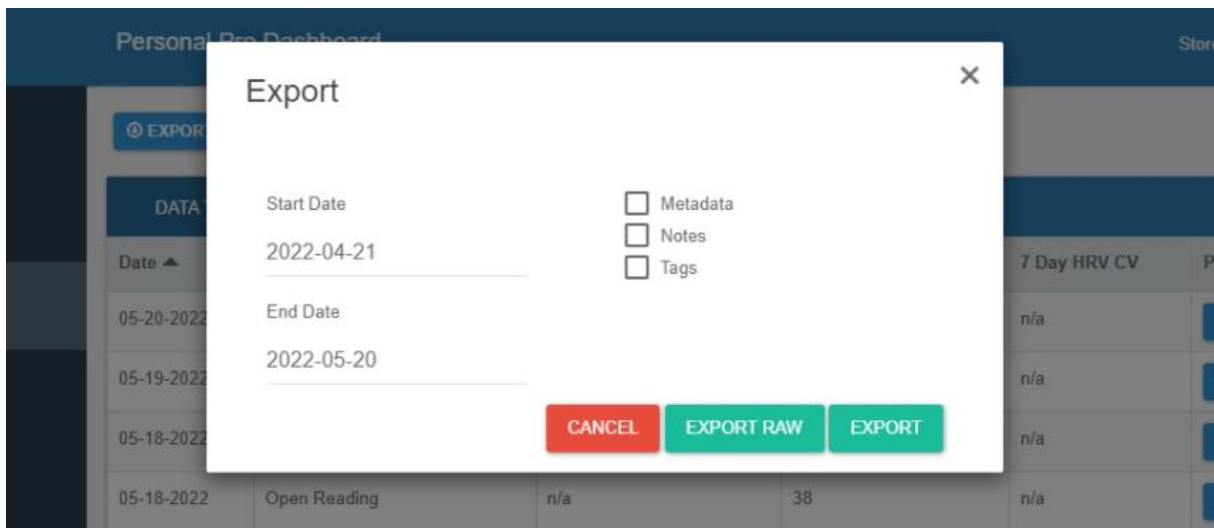
The data measured by Polar are saved on the Elite HRV dashboard reachable via this URL: <https://dashboard.elitehrv.com/>. A login form allows you to log in to your Elite HRV account.



Once logged, choose **Personal Dashboard**. All, the data of the session are available by selecting the **Data** tab:

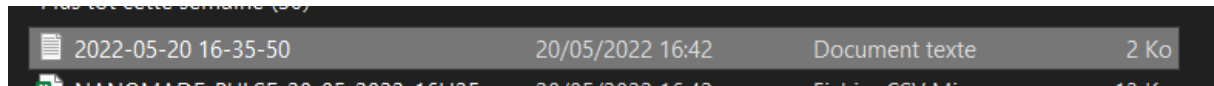


To export the data, press **Export**, select the date interval of your measurements and then press **Export Raw**:





A new text file is downloaded on your Downloads folder as follow:



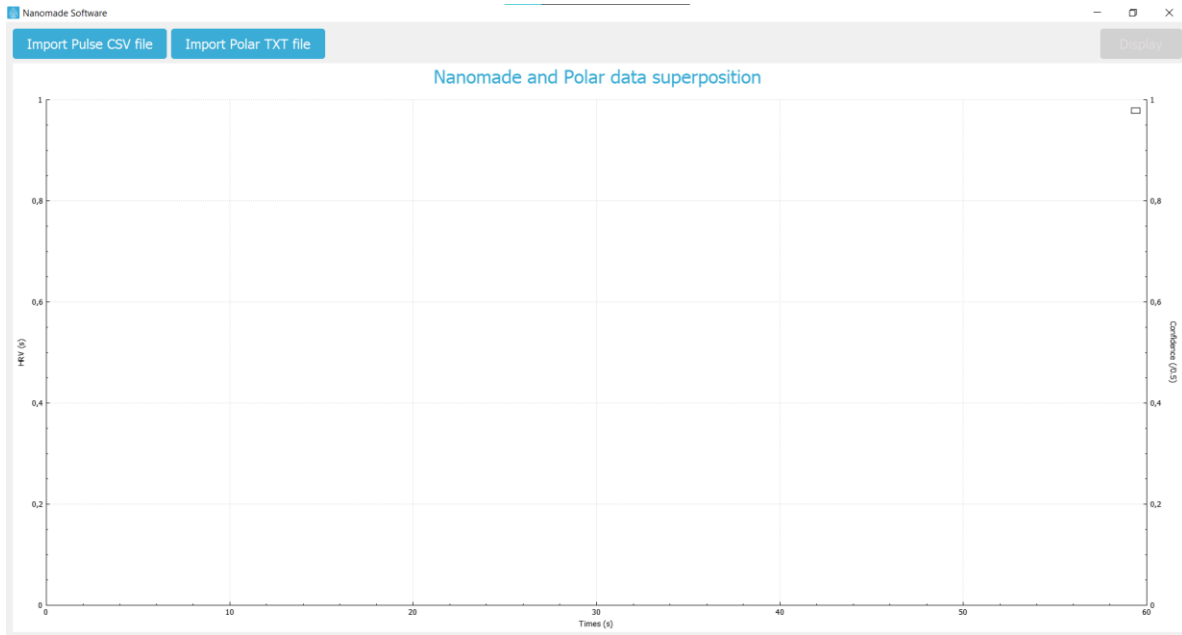
This file contains all the data measured by Polar H10. Below is an example of the contents of such file content:

```
909
932
928
902
924
954
927
942
984
964
931
963
980
943
904
955
1039
1011
1018
1030
```

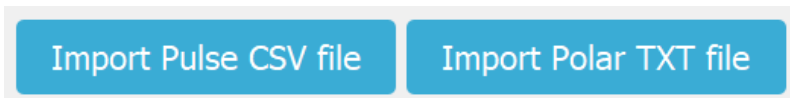
Comparison Software

To compare the Polar and the Pulse data, it is necessary to use the comparison software by launching the executable SYNCHRO_CHART.exe in the folder */COMPARISON*.

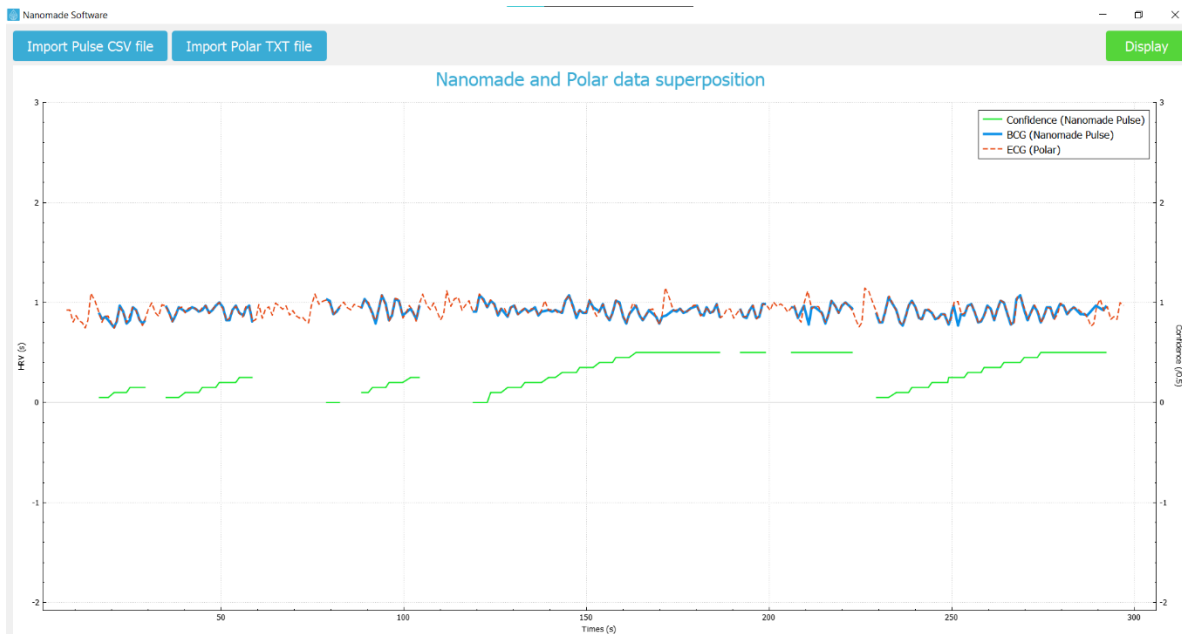
When launching the software, the following window should appear:



You can import the Pulse CSV file and the Polar TXT file by clicking on the corresponding button:




Once the two files are imported, click on the **Display** button to launch the comparison. The following window appears, and a similar chart should have been drawn.




You should see 3 different curves:

— — — — — The Polar IBI in milliseconds



 The Nanomade IBI in milliseconds

 The confidence index curve. Each measure recorded by the Nanomade Pulse are associated to a confidence index between 0 (low precision measure) and 10 (high precision measure).