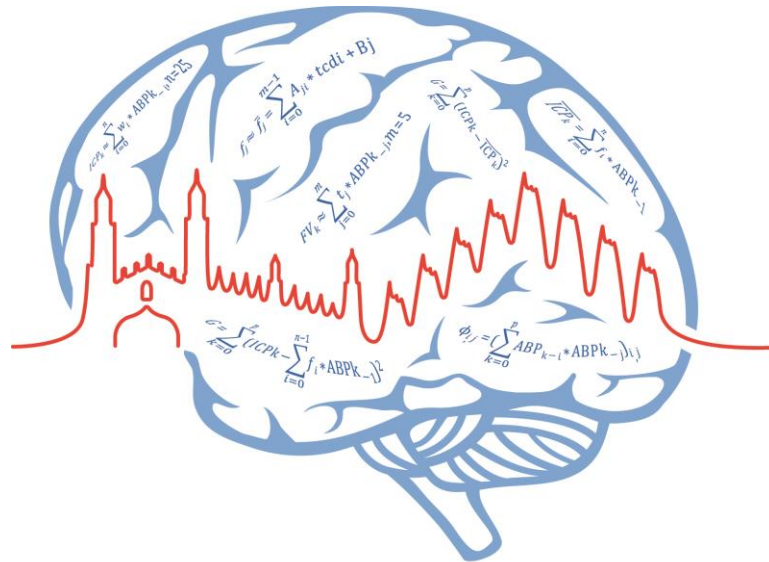


ICM+ Standard of Procedures



ICM+[®]

Delica TCD monitor with non-invasive ABP monitor

14 June 2017

<http://www.neurosurg.cam.ac.uk/icmplus>

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Prerequisites

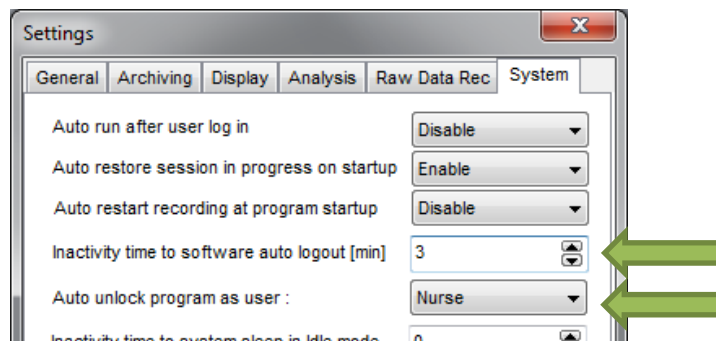
1. **A laptop (or a PC) with the latest ICM+** plus Delica TCD and Data Translation A/D converter module installed. This may not be necessary if ICM+ is to run on the Delica monitor itself.
2. **Delica TCD monitor, with the latest software version**
3. **Non-invasive arterial pressure monitor** (eg Finapres)
4. **Appropriate cables**
 - a. Network cable for connection with Delica monitor (or none if ICM+ is installed on the Delica computer)
 - b. Analogue cable connecting the non-invasive pressure monitor with the A/D converter – the exact cable will depend on the models of the monitor and the converter used. This may be supplied by Delica with the new TCD model that takes non-invasive ABP input and offers nABP signal to collect digitally alongside flow velocity signals.
 - c. USB cable between the converter and the laptop\desktop with ICM+ (not needed if non-invasive ABP module is supplied with the Delica TCD)

Locking and unlocking ICM+

ICM+ includes a simple system of user based permissions, which allows it to be used safely in a clinical environment, also by people with minimal training, ensuring that the vital data collection process is not inadvertently interrupted or disturbed.

If your ICM+ is correctly configured when the program is run it will automatically initialize with the default user 'Nurse'. There are three other users already configured in ICM+, the Administrator, the Manager and the Operator. The users have been configured with progressively decreasing operational rights.

The **Nurse** is the user with the fewest rights in the software, effectively only being able to insert clinical events, browse the charts and starting new sessions, without any possibility to disrupt the data collection procedure. Please refer to the 'How to use the events form' for more details. After 3 minutes of inactivity (configured in the settings, figure below), ICM+ automatically switches to the default user, if configured, which for the data collection should be set to **Nurse**.

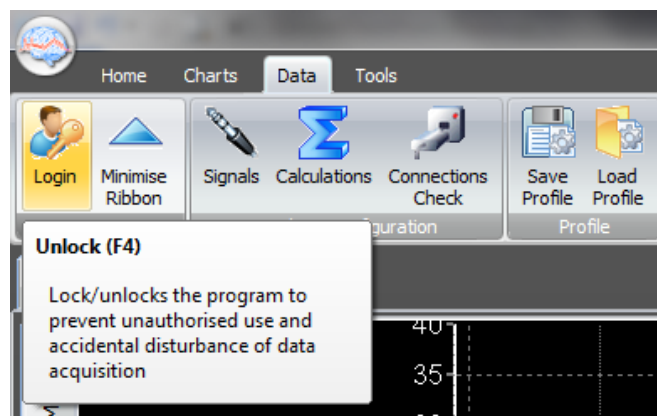


The **Administrator** is the user that will have full access to the full features of the application.

The **Manager** will have the same privileges but will not be able to manage user accounts.

The **Operator** will only be capable of starting new Recording sessions with available profiles, browsing data, inserting clinical information and display configuration.

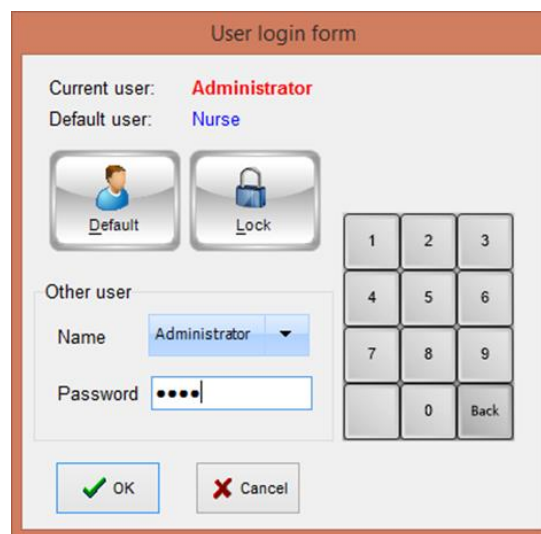
Login (change users) form is accessible via a button on the main menu bar.



Or the speed tool bar, when the data collection is in progress



When the Login button is pressed, the User login form will appear.

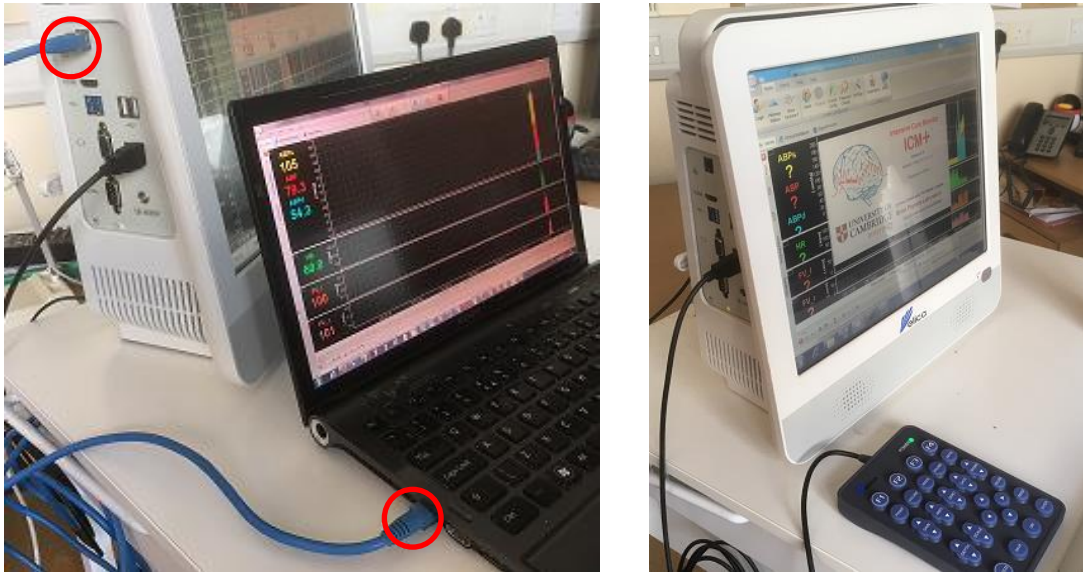


The 'User login form' dialog box displays the current user as 'Administrator' and the default user as 'Nurse'. It features a 'Default' button with a user icon and a 'Lock' button with a padlock icon. Below these are fields for 'Other user' with a 'Name' dropdown menu set to 'Administrator' and a 'Password' field with masked characters. To the right is a numeric keypad with buttons for digits 1-9, 0, and a 'Back' button. At the bottom are 'OK' and 'Cancel' buttons.

In this form you will find:

1. A button to the Default user and a button to lock the application so that nothing but the login button is accessible.
2. A key pad to insert the Password for a given use.
3. And a Drop-Down menu to select the user to login as.

Connecting to the Delica monitor

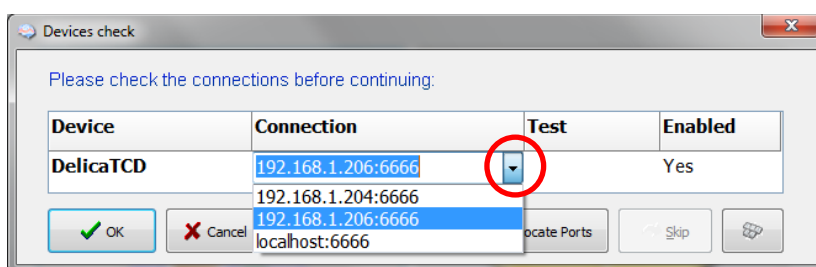


Connection of ICM+ to the Delica monitor depends on whether ICM+ is installed on a separate laptop, or on the Delica monitor itself. In the former case a standard network cable is required to connect the laptop with the monitor, using network ports on both, as illustrated in the picture here (left).

In the latter case (ICM+ running on the Delica monitor) no additional cables are needed as the communication is entirely internal (using internal, local host address), picture on the right.

If external laptop is used, both the laptop and the Delica monitor must be configured with IP addresses on the same subnet (see Appendix 5 for the network configuration guide). For the second option (installation of ICM+ on the Delica computer) the IP address settings are irrelevant to the communication.

Once the network settings are configured and the physical connection established (not needed for ICM+ installed on the Delica computer) the matching IP address and port needs to be configured in ICM+. This can be done either in the Device Check dialog box, as shown below and mentioned again in the next section:



In the figure below one can see a list of last used IP addresses (displayed when the little arrow in the Connection column is clicked). Please note that the IP addresses are followed by a ':' character and a number, which corresponds to the TCP/IP port configured in the Delica monitoring set up, as shown below (copied from Delica TCD manual). If ICM+ is running on Delica monitor 'localhost' address must be selected, otherwise the correct IP of the Delica monitor entered (or selected from the list).

Monitoring Setup

Vessel | Index & Envelope | Warning | Manual Event | HITS | Analog Input | **Analog Output**

PIN	Ev.	Uni-channel	Bi-channel
0	Upper	1-1 Vp U	1-1 Vp U
1	Lower	1-1 Vp L	1-1 Vp L
2	Upper	1-1 Viwm U	1-1 Viwm U
3	Lower	1-1 Viwm L	1-1 Viwm L
4	Upper	1-1 P U	2-1 Vp U
5	Lower	1-1 P L	2-1 Vp L
6	Upper	1-1 PV U	2-1 Viwm U
7	Lower	1-1 PV L	2-1 Viwm L

The range of analog output

High value: 120.0

Export analog output

Port: 6666

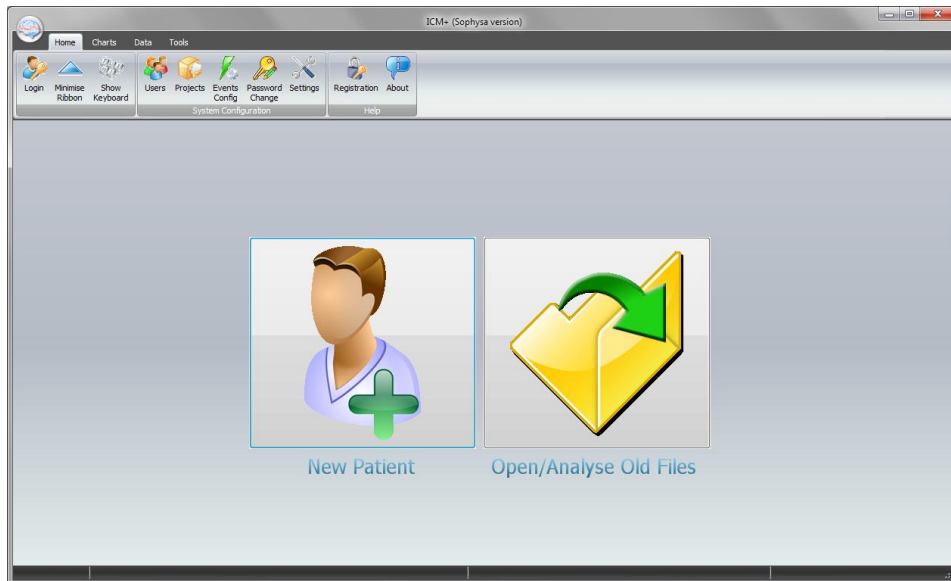
Data export

Display analog output curves in main Doppler window

OK Cancel

Starting a new data collection session

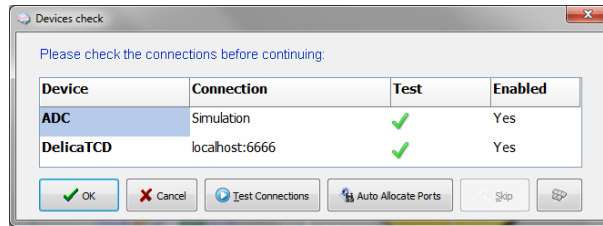
To create a new data acquisition session hit New Patient button.



This will bring up a new form, where patient details can be inserted:

More importantly a data acquisition/analysis profile (configuration) file should be selected, either from the history list box or loaded from the file system. These can then be modified if necessary using Signal Sources editor, or On Line Analysis editor.

After the OK button is clicked, the Devices check is performed using Device Check dialog.

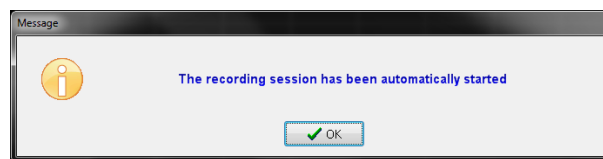


This dialogue is used to test the communication between the ICM+ and the monitor (the 'Test connections' button). If the test is successful the OK button can be pressed.

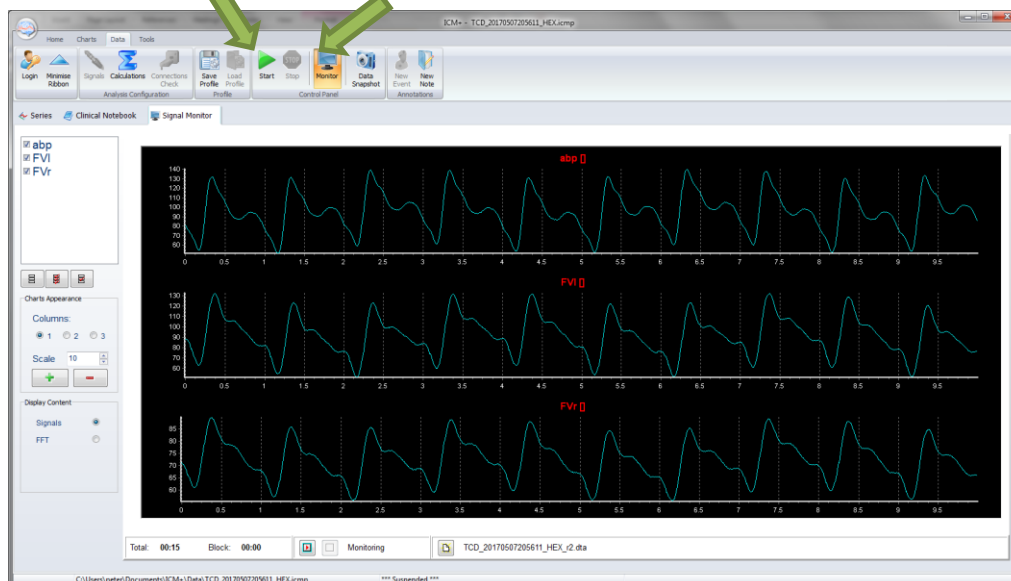
This menu can also be used to select the right connection, whether it is a serial connection (like the one presented in the picture) or an IP address. In the case of a serial port connection, the button auto allocate ports can be pressed and the application will search for the right port.

In the Delica dedicated version of ICM+ connection to the TCD monitor will be tested automatically and the dialog will close automatically after the test. If the test initially fails different serial (COM) ports available in the computer will be tested until the connection is established or all options are exhausted.

After this dialogue, ICM+ main display is presented and the session begins recording automatically, if configured in the used project. Otherwise use Start button (see next page).

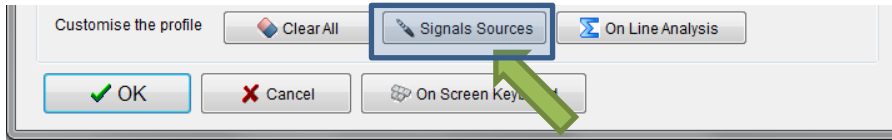


If ICM+ **shuts down during a recording session** the next time it is run, the previous session is automatically restored, but here the user must first verify that all the signals are being received correctly in the Monitor button. After this the Start button must be pressed and the session resumes recording.

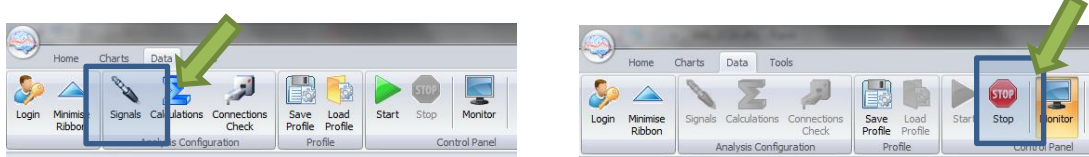


Manually configuring data collection

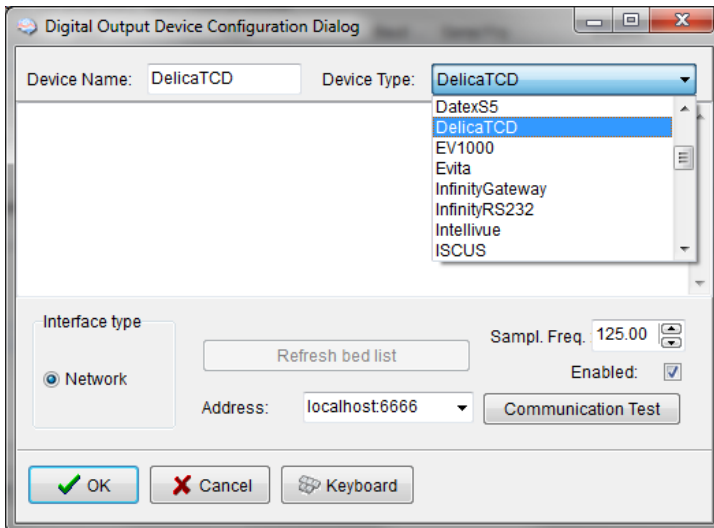
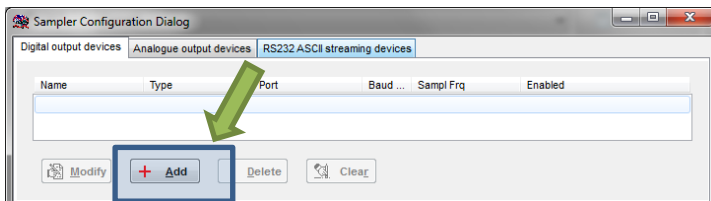
If there is no prepared profile available that includes desired data collection from the monitor or if there is a need to modify or add parameters downloaded from the monitor Signal Sources option needs to be used. This can be done in the New Data Acquisition Form:



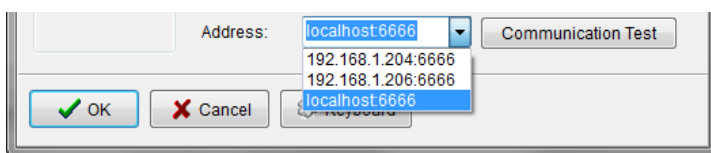
Or using Signals button in the main Menu (Data Section), with the data acquisition in pause mode. Please note that the recording must be stopped before the Signals button becomes enabled

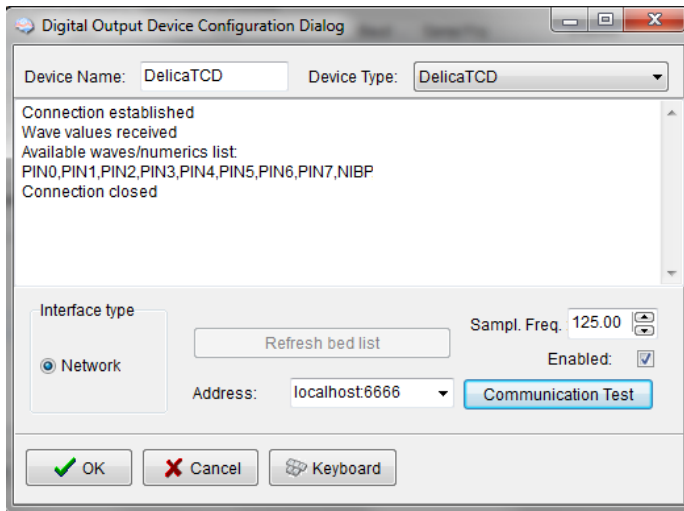


This brings up the Sampler Configuration form:



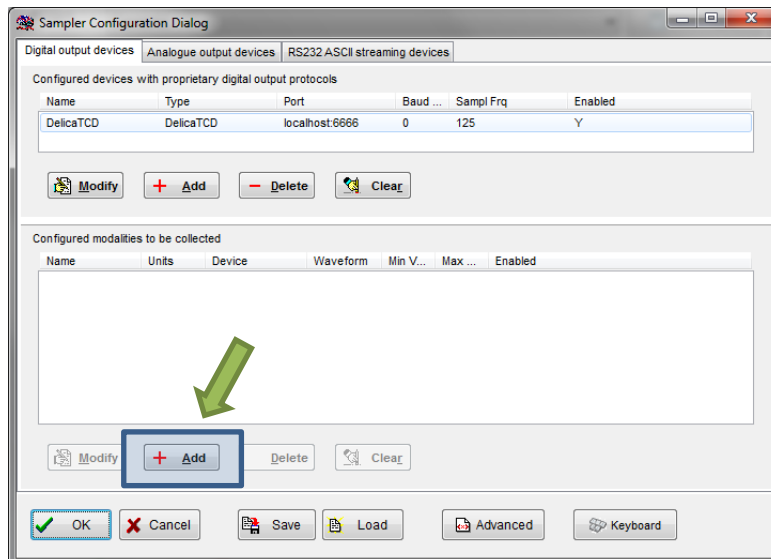
Clicking on Add button in the upper part (Digital Output devices tab) opens a Device Configuration dialog. Here, one can select the monitor module from the list of available (installed) interfaces, as well as specify the IP address of the Delica TCD monitor (or 'localhost' for internal connection, if ICM+ is installed on the Delica monitor).



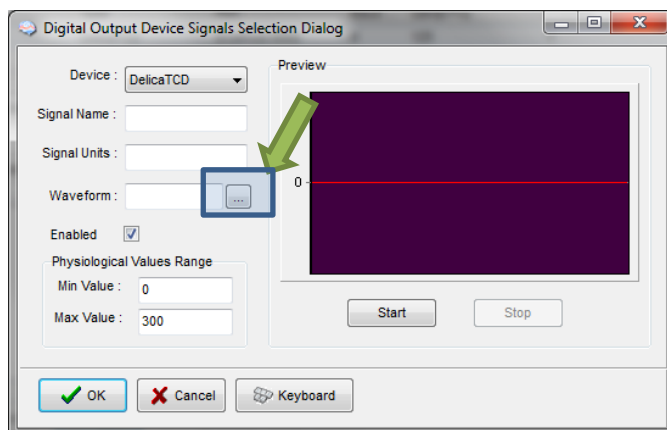


When the correct interface module (DelicaTCD) and the correct IP address (and port), (see appendix 2 below for more details), clicking on 'Communication Test' will try to establish communication with the monitor and the log of that communication is printed in the memo box, listing also all the parameters that are available to download from the monitor.

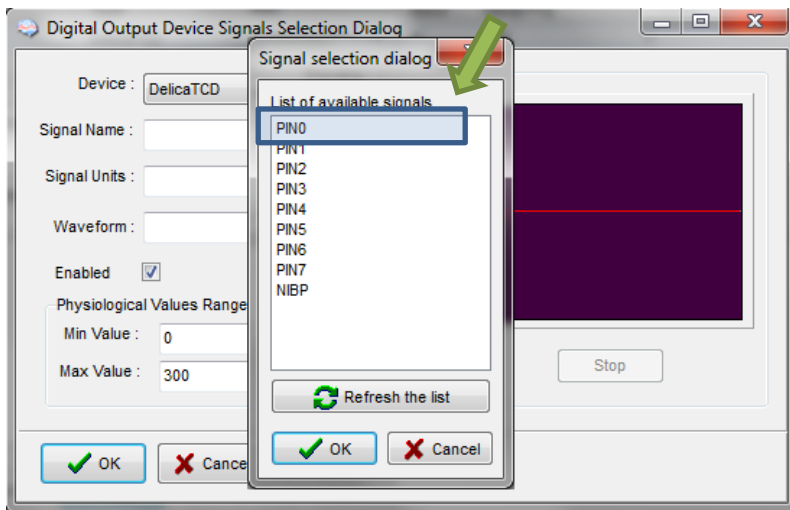
After the connectivity is confirmed the dialog can now be closed, which causes the device to be added to the data collection configuration. What remains to complete the configuration is adding all the desired parameters to be collected. This can be achieved by using the Add button in the lower part of the Sampler Configuration dialog.



This opens a signal selection dialog:



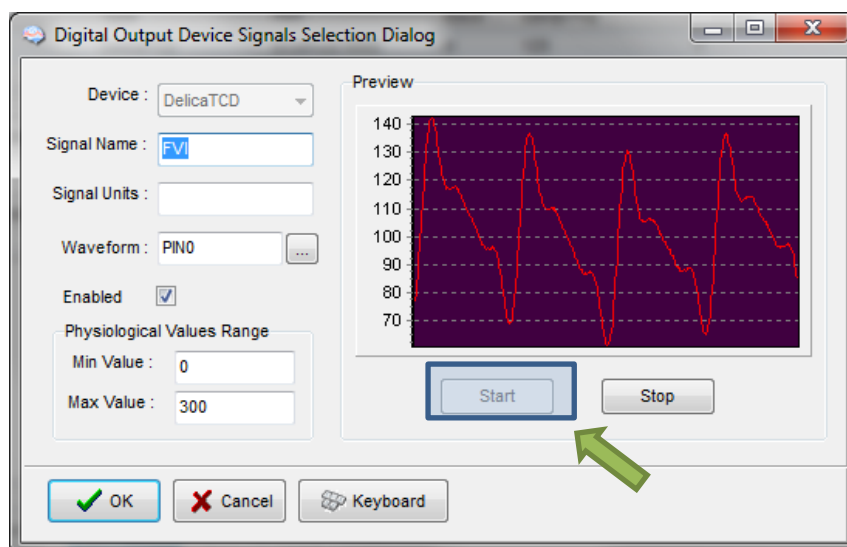
Using the little '...' button one can select available signal, one at a time.



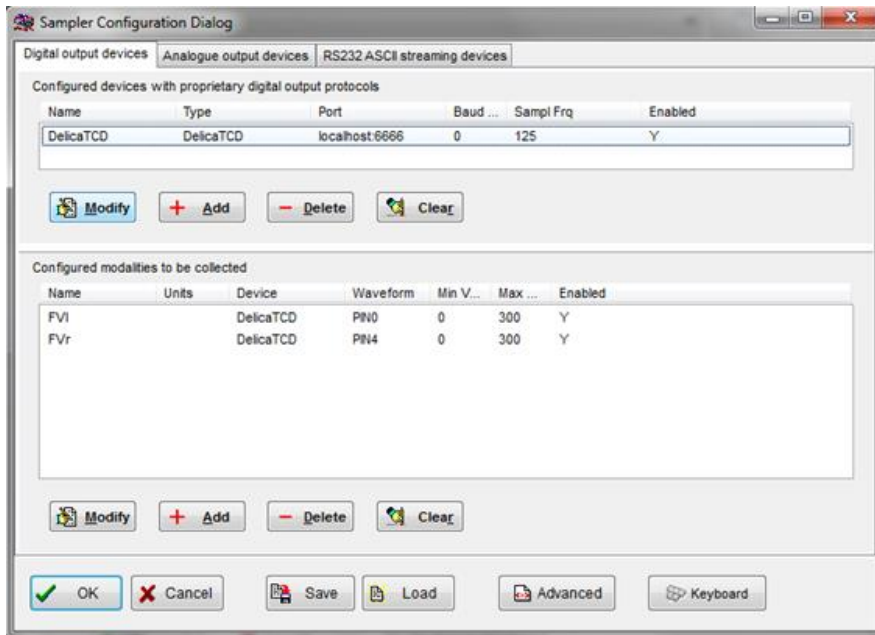
The listed parameters include variables labelled as Pin0-7, which correspond to measurements as described in the Delica Monitoring Setup

Vessel	Index & Envelope	Warning	Manual Event	HITS	Analog Input	Analog Output
PIN	Enn.	Uni-channel	Bi-channel			
0	Upper	1-1 Vp U	1-1 Vp U			
1	Lower	1-1 Vp L	1-1 Vp L			
2	Upper	1-1 Viwm U	1-1 Viwm U			
3	Lower	1-1 Viwm L	1-1 Viwm L			
4	Upper	1-1 P U	2-1 Vp U			
5	Lower	1-1 P L	2-1 Vp L			
6	Upper	1-1 PV U	2-1 Viwm U			
7	Lower	1-1 PV L	2-1 Viwm L			

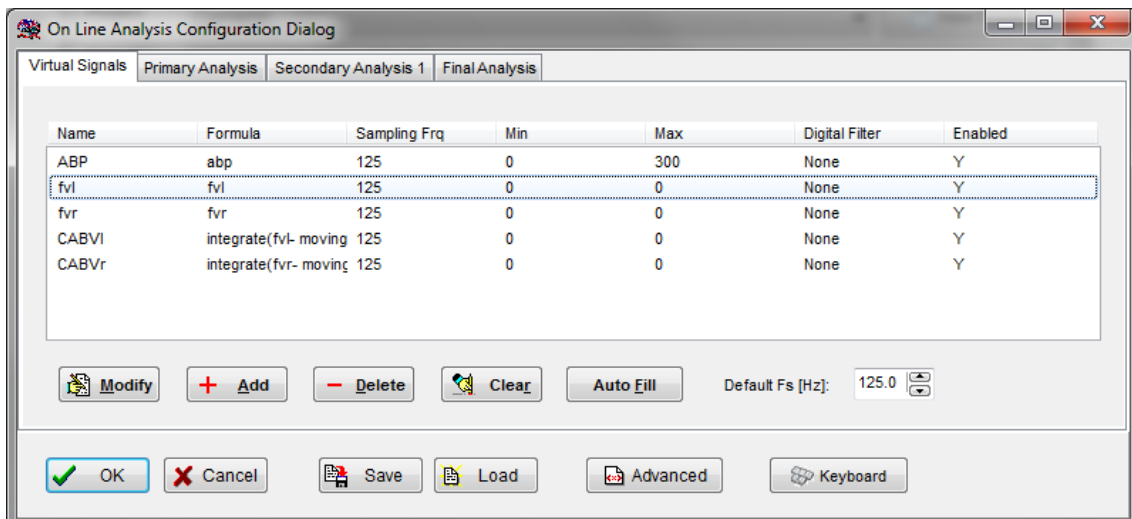
Once the waveform is selected one can test the data acquisition by clicking on Start button. If all is well OK button will close the dialog and add the new parameter to the data acquisition configuration.



This process can be repeated as many times as it is needed putting together the complete list of parameters to be collected, which complete the data acquisition configuration procedure.



Please note, that adding parameters/signals to the data collection will make ICM+ show and record the data through the Signal Monitor window but the trends charts will not automatically get configured to show them. This is because the trend charts only show results of calculations, not the raw data. So to display even just a mean trend of a newly added variable collected from the monitor ICM+ this needs to be configured first in the analysis section, as in picture below, and then the new trend added to the charts.



Annotating clinical events

As soon as the acquisition of data starts the main menu tool bar will get minimised and in its place a small, 'data acquisition essentials', tool bar will open, as below.



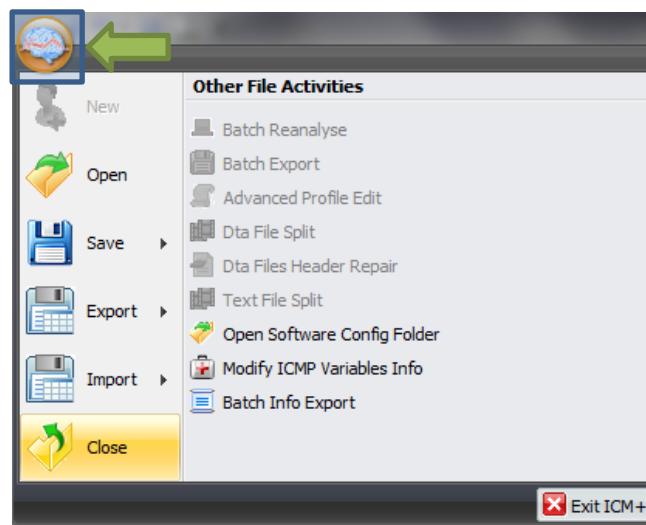
There, from left to right the following functions are accessible:

1. Log-in/Log-off form – to change the user (ie privileges)
2. Patient discharge/stop data collection session
3. Event annotation form (which will be disabled if no events are configured)
4. Free textual annotations form
5. An on-screen keyboard
6. The last button closes this tool bar and unfolds the main menu toolbars

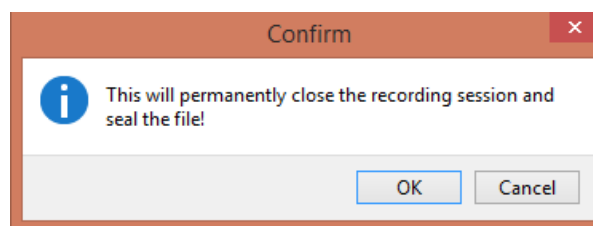
Terminating the data collection session and archiving the data

When the data acquisition process is finished the recording session can be closed using the Close button present in the ICM+ button. This will initialize a cascade of forms that will eventually lead to the sealing of the file and subsequent archiving the data to the file server, if required.

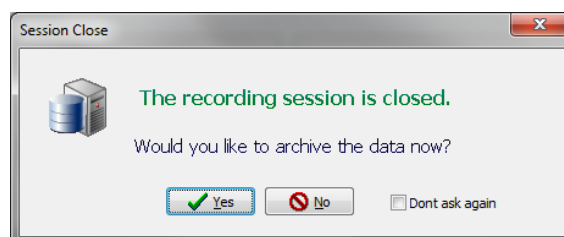
Closing a session is different from closing the program. To close the ICM+ application you need to press the red cross present on the upside corner of the right side of the screen. If ICM+ is closed (Exited) using this button or if the computer shuts down, the next time it is run, the recording session will be resumed with the same configurations it had at the moment of shutdown.



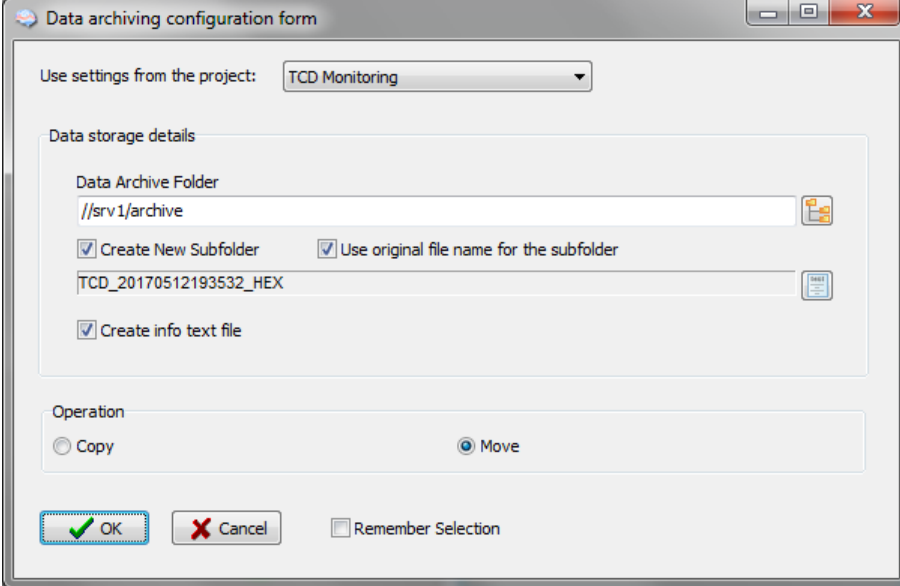
When this button is pressed a dialogue is presented prompting the user to confirm the closure of the recording session:



After confirming the end of the recording session another dialogue is presented prompting the user to archive the data:



After confirming this dialogue the Data Archiving Form is presented, where the user can specify/confirm the location of the server and its share to use:



The image shows a Windows-style dialog box titled "Data archiving configuration form". At the top, it says "Use settings from the project:" followed by a dropdown menu set to "TCD Monitoring". Below this is a section titled "Data storage details" which contains several fields and checkboxes:

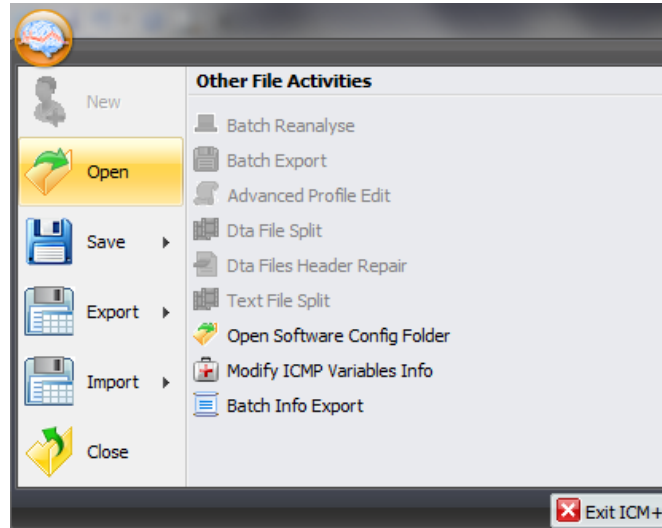
- "Data Archive Folder" with a text input field containing "//srv 1/archive" and a folder icon button to its right.
- Two checked checkboxes: "Create New Subfolder" and "Use original file name for the subfolder".
- A text input field containing "TCD_20170512193532_HEX" with a folder icon button to its right.
- A checked checkbox: "Create info text file".

Below the "Data storage details" section is an "Operation" section with two radio buttons: "Copy" (unselected) and "Move" (selected).

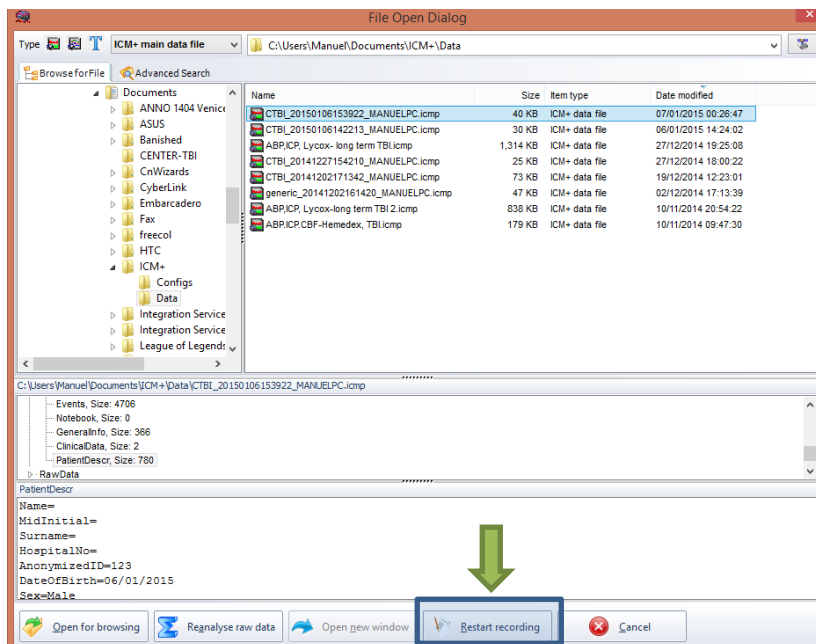
At the bottom of the dialog are three buttons: "OK" (with a green checkmark icon), "Cancel" (with a red X icon), and "Remember Selection" (with an unchecked checkbox).

Restoring a closed data collection session

If a session was for some reason closed and a recording needs to be restored again the button open can be pressed.



The dialog that opens can be used to reopen the file in order to upload the data to our servers or to restore the recording session.

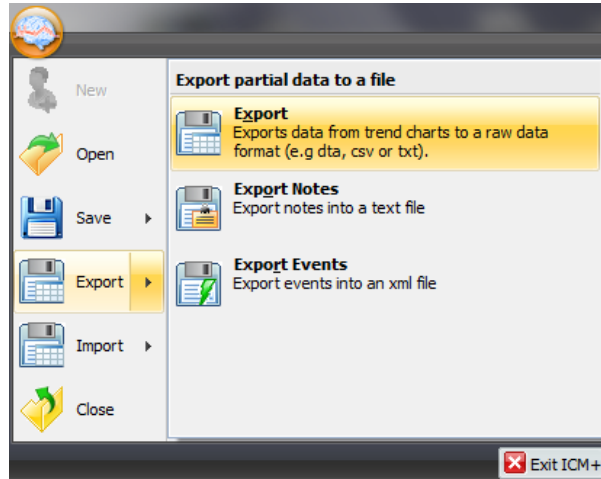


To reopen a file for inspection or to upload it is only necessary to double-click the desired file.

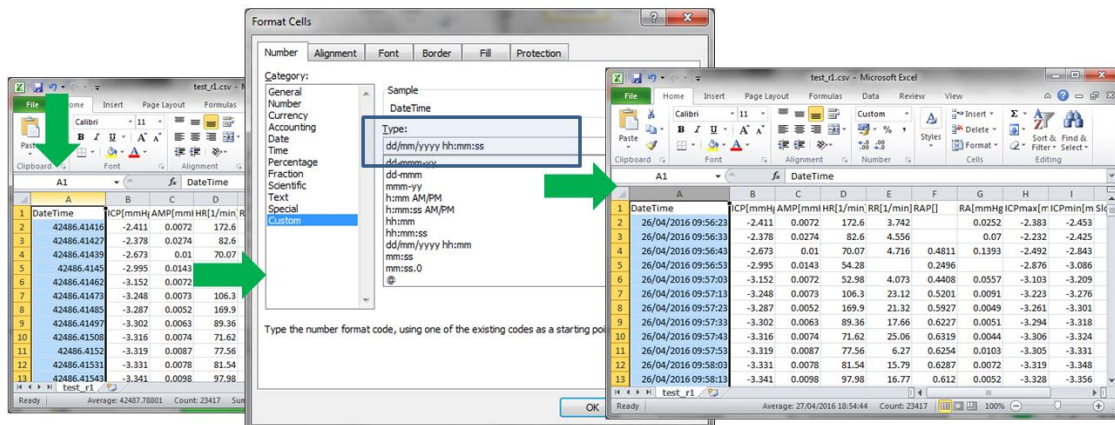
To restore the recording session, the highlighted button must be pressed and the recording resumes using the same profile as when it was closed.

Exporting data to a csv (Excel) format

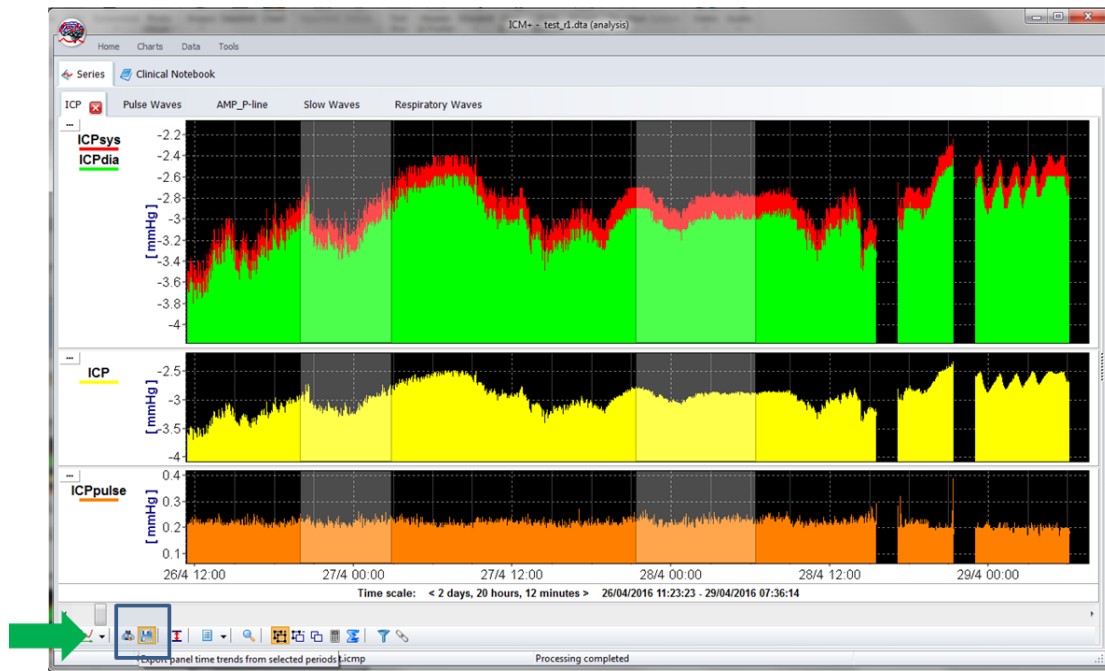
There are two ways the data can be exported from ICM+. One way is to select Export option in the main menu (the Brain icon).



This will export all the trend data from the memory, all the variables, in commas separated columns of values, with the first column containing the time stamps, in the internal Windows DateTime format. The DateTime format is essentially a number of days (and their fraction, which translate into time) since 31/12/1899. Imported into Excel it will initially showed up as those numbers, but if date or time (or combined) cell formatting is requested for that column the data and or time will be shown.



The second way of exporting data is to use the data export chart tool, located at the bottom of each charting vertical panel:



This will export data only from the variables plotted in the panel corresponding to the button toolbar, in this case it will be ICPsys, ICPdia, ICP and ICPpulse only, and only from selected time periods, if the selection tool is used, or the whole recording time, if not.

	A	B	C	D	E	F	G	H
1	DateTime	ICPsys[mmHg]	ICPdia[mmHg]	ICP[mmHg]	ICPpulse[mmHg]			
2	42668.57096	216.4	-3.937	0.744	220.4			
3	42668.57108	-2.629	-2.899	-2.743	0.2701			
4	42668.57119	-2.481	-2.647	-2.554	0.1663			
5	42668.57131	-2.406	-2.594	-2.511	0.1877			
6	42668.57142	-2.396	-2.594	-2.498	0.1984			
7	42668.57154	-2.396	-2.567	-2.484	0.1709			
8	42668.57166	-2.396	-2.539	-2.481	0.1434			
9	42668.57177	-2.396	-2.539	-2.476	0.1434			
10	42668.57189	-2.387	-2.539	-2.471	0.1526			
11	42668.572	-2.387	-2.521	-2.468	0.1343			
12	42668.57212	-2.341	-2.521	-2.462	0.1801			
13	42668.57223	-2.368	-2.53	-2.464	0.1617			
14	42668.57235	-2.359	-2.503	-2.459	0.1434			
15	42668.57247	-2.341	-2.521	-2.453	0.1801			
16	42668.57258	-2.313	-2.503	-2.431	0.1892			
17	42668.5727	-2.332	-2.512	-2.43	0.1801			
18	42668.57281	-2.313	-2.503	-2.426	0.1892			
19	42668.57293	-2.313	-2.503	-2.431	0.1892			
20	42668.57304	-2.332	-2.503	-2.433	0.1709			
21	42668.57316	-2.322	-2.503	-2.425	0.1801			

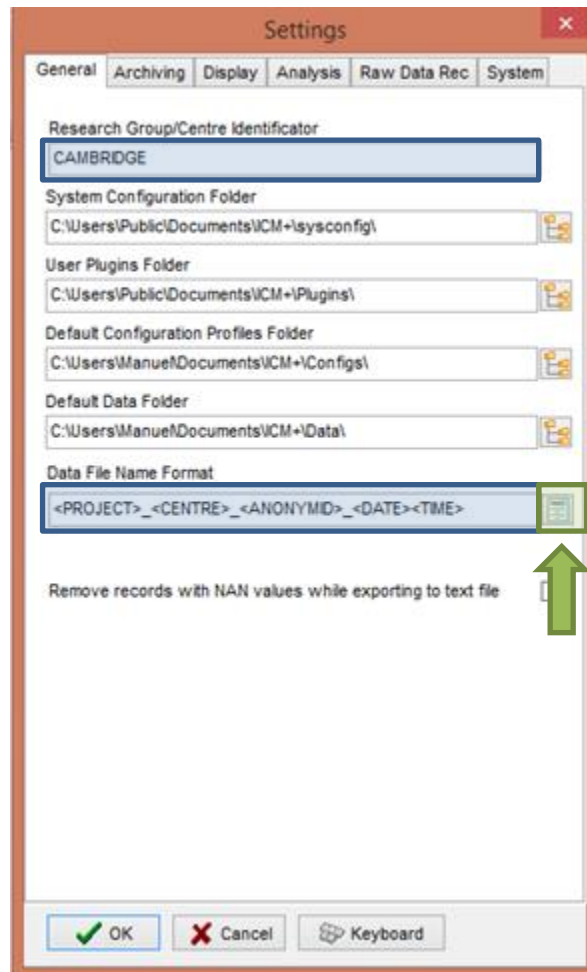
Appendix 1: Configuring ICM+ system options

Most of the programmable behaviours of the software can be adjusted via the Settings menu. This menu can be found by clicking the Home tab and the Settings button.



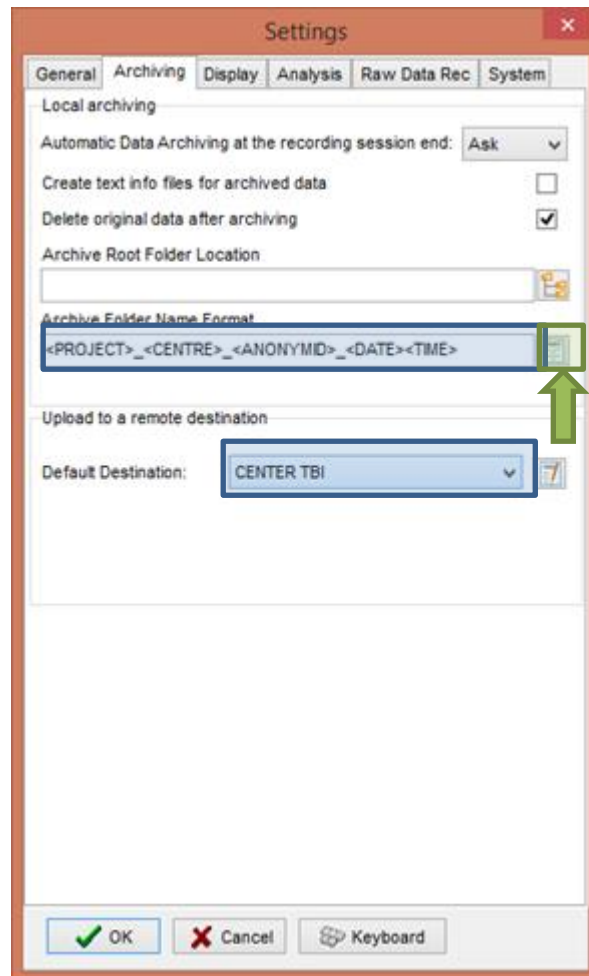
In the Settings menu you will need to configure several things:

- On the General tab:



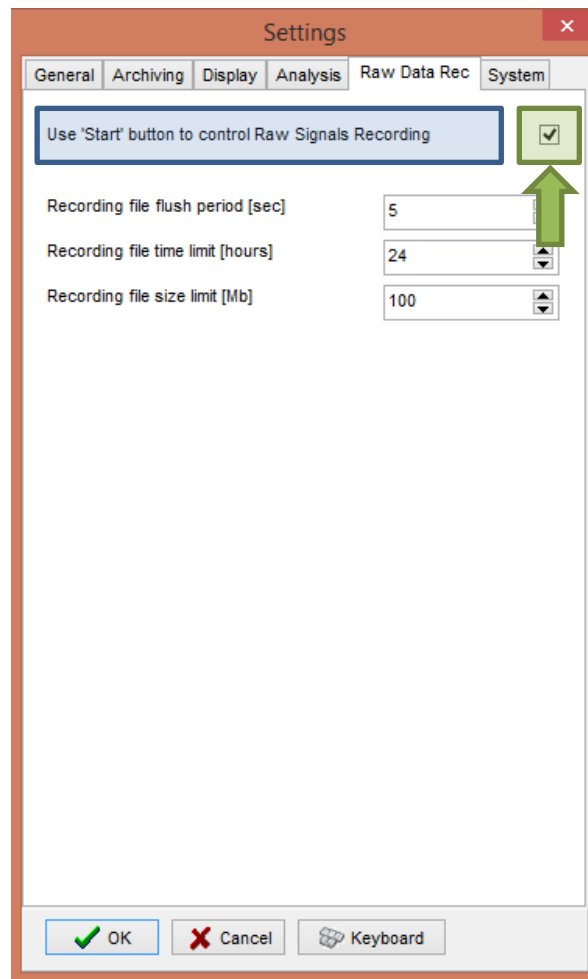
- The Research Group/Centre identification will be a unique name in the project that will identify the centre. This name should be fully inserted in capitals (ex. CAMBRIDGE).
- The **Data File Name Format** will be used to configure the structure to be used on the construction of the name of each data file. As each file generated in the study must have a unique identifier we agreed in using a structure that uses the format highlighted in the picture. A description on how to build this File Name format is presented further down in this appendix.

- On the Archiving tab:



- The Archive Folder Name Format will follow the same structure as the Data File Name Format. This setting is used for organising local archival storage of the data files.
- The remote server Upload (accessible via the upload function) default Destination can be selected here but it is the matching setting in the Project configuration that will ultimately take precedence.

- On the Raw Data Rec tab:



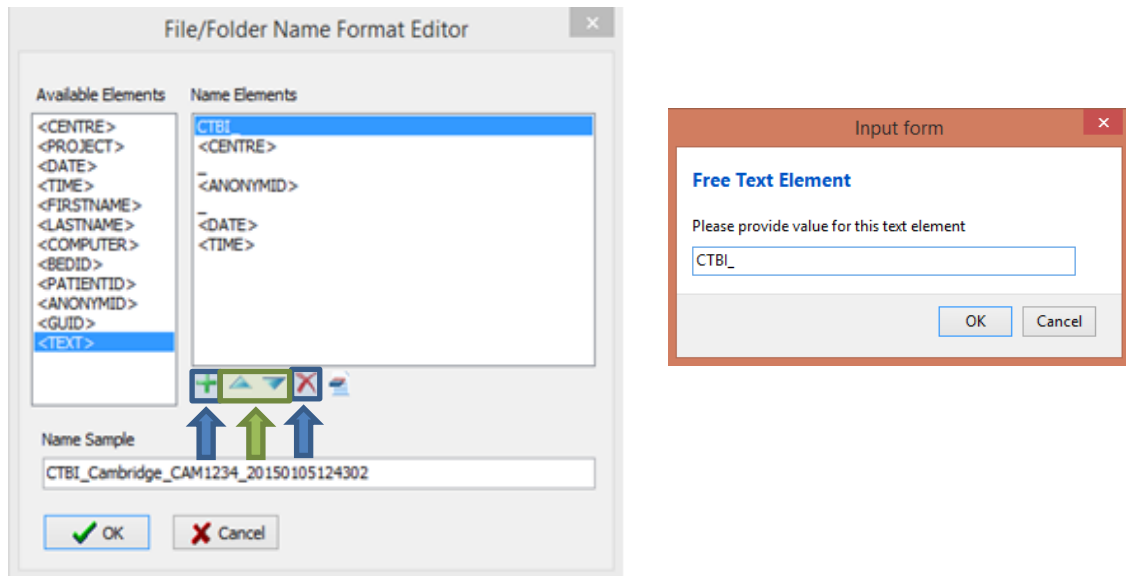
- The Use 'Start' button to control Raw Signals Recording **must be checked if you are using ICM+ to record any data directly from bed side monitors**

- On the System tab:

The screenshot shows the 'Settings' dialog box with the 'System' tab selected. The 'Auto unlock program as user' dropdown menu is highlighted with a blue border and set to 'Nurse'. Other settings include 'Auto restore session in progress on startup' (Enable), 'Auto restart recording at program startup' (Enable), 'Inactivity time to software auto logout [min]' (0), 'Operating System Policy' (Use this program instead of Windows shell: Disable, Disable logoff/shutdown: Disable, Disable Task Manager: Disable, Disable locking the computer: Disable, Disable Windows password change: Disable), 'Windows Auto Login' (State: Disable, Password: empty, User: empty, Confirm: empty), and 'Patient description encryption' (Passphrase: empty). Buttons for OK, Cancel, and Keyboard are at the bottom.

- Set the Auto unlock program as user to Nurse. Setting the inactivity time to a value greater than 0, eg 10 min, will cause the software to auto log-in as that default user following a selected period of time without interaction with the software (this will only happen of course if the program was unlocked as another user)

To build the **Data File Name Format** you will need to click the highlighted button and the following form will appear:



In this form it is possible to add/remove any name element present in the Available Elements menu.

The '_' and any additional static text can be inserted by using the element '<text>' and inserting the text to be added manually.

Appendix 2: ICM+ configuration folders and files

ICM+ uses two locations (configurable via the Settings form) to store all its configuration files:

Location 1: C:\Users\\Documents\ICM+.

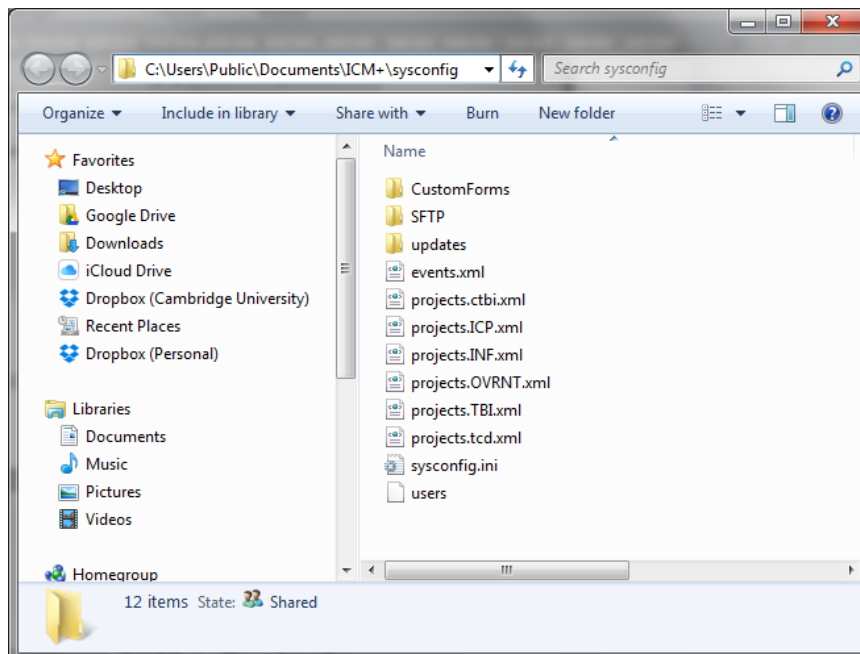
There are two subfolders here:

‘**Data**’ folder, where all the data recorded during the acquisition process is stored, and

‘**Configs**’ folder, used to store the data collection and analysis configuration ‘profile’ files, as in the figure below.

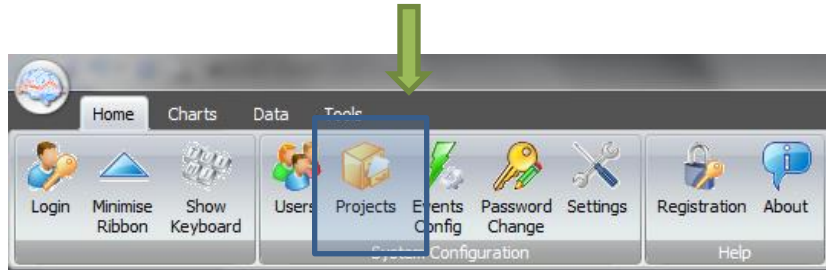
Location 2: C:\Users\Public\Documents\ICM+

Here all the environment configurations/settings are stored. This location contains a folder called **Plugins**, where 3rd party function libraries reside, a folder called **TxtFilters**, containing parsing definitions for different text format data files, and a folder called **sysconfig** containing all the settings of the software, except the data collection and analysis profiles which are store in the Location 1 (as above). Although these files could be edited directly using a text editor ICM+ has specific user interface forms to edit all aspects of the program functionality.

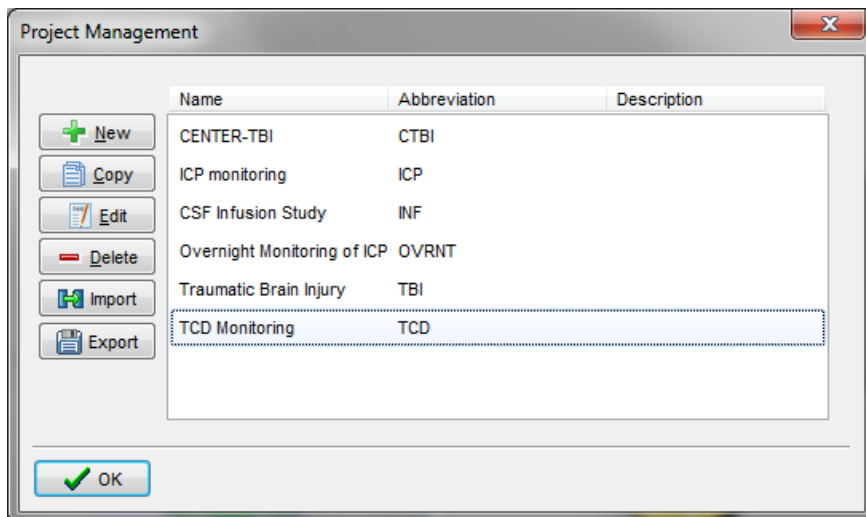


Appendix 3: Editing ICM+ Projects

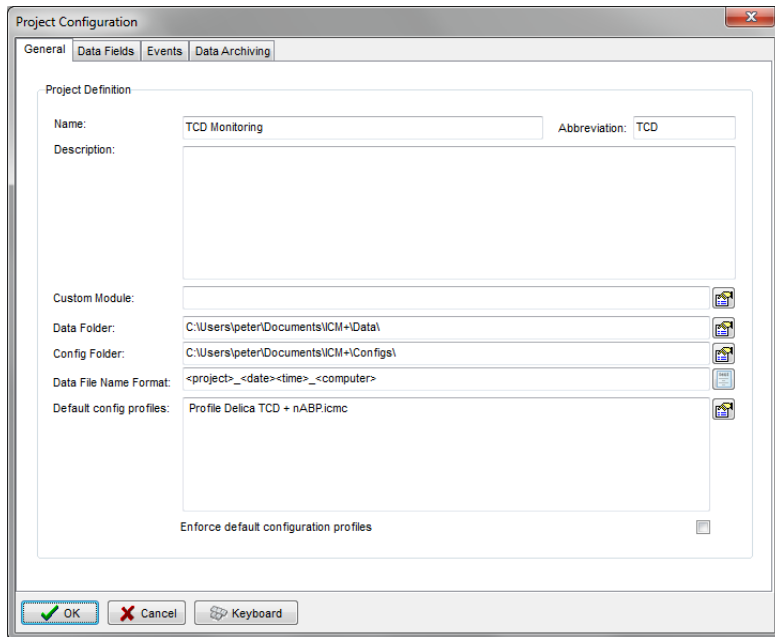
Projects contain various configurations specific to a particular research project. These can be edited using **Projects** button in the main menu tool bar.



Clicking this button will open the Project Management dialogue, where you create, copy, edit, delete, export/import selected projects to/from a file.



Double clicking on a selected project or clicking on Edit will open a Project Editor where all the custom project settings can be modified.



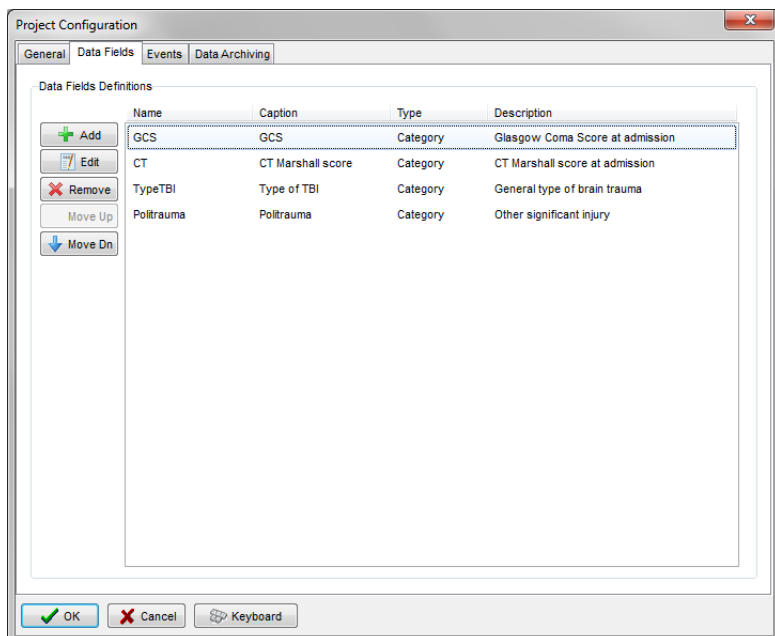
1 . The project **abbreviation** will be part of the file name

2. '**Data Folder**' is a local folder where the data collected as part of this project will be stored

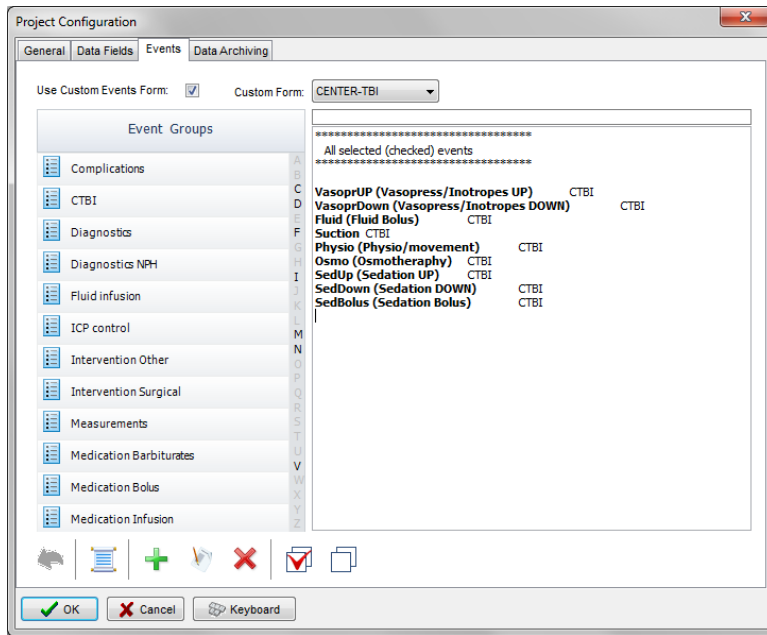
3. '**Config Folder**' is a folder (could be a network share) where the data configuration profiles are kept

4. **Data File Name Format** lists elements that will be used to create automatic file names for each new data acquisition sessions.

5. **Default config profiles** lists profiles that will be available to select in the new data acquisition forms.

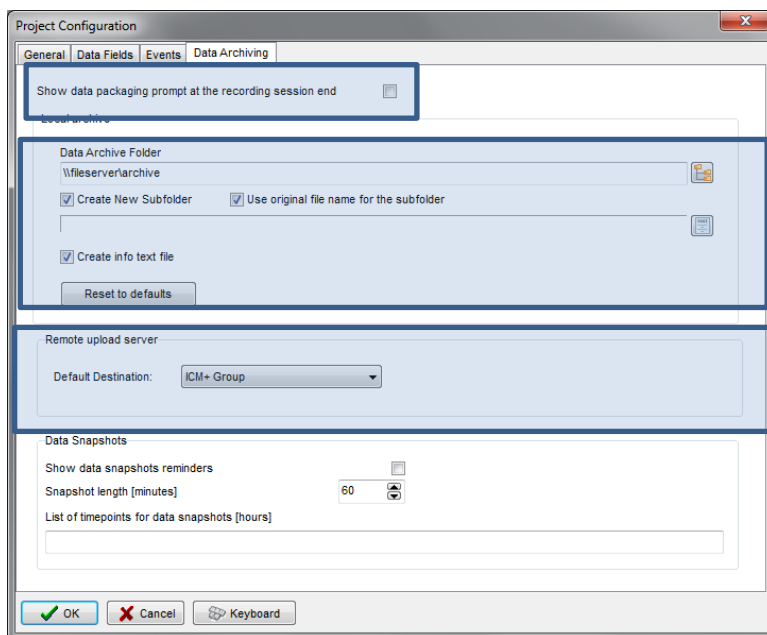


The data fields define placeholders for general clinical descriptors that characterise the patient at the time of admission to the critical care unit, that are useful to be kept together with the monitoring data.



This is where events that are already defined elsewhere (in the Events form), listed in the left panel (1), can be assigned to the particular project (listed in the right panel 2.).

Please note that there is also an option of using a customised event form (designed for CENTER-TBI project), selected using the 'Custom Forms' list box (3). It is possible however to add more events to the project but those will only be accessible from within the 'Event List' panel, toggled from the main menu tool bar panel, Charts section.



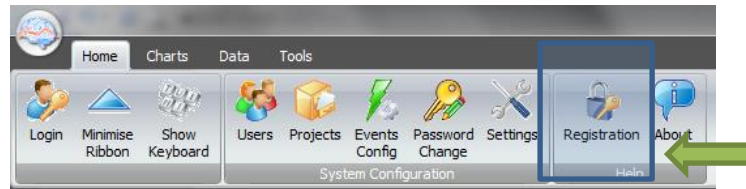
Here one can define the location and type of data archive procedure:

1. This should be ticked in order for you to be prompted to convert the file to archiving HDF5 format at the end of the recording session
2. Location of a local file server for data archiving,
3. the destination of a remote SFTP upload data server, configured in the Settings, and facilitating multicentre data collection projects

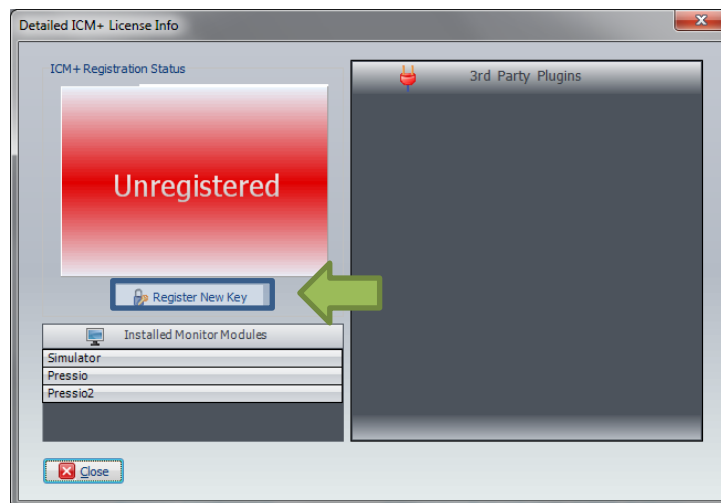
Appendix 4: Registering ICM+

When ICM+ is successfully installed for the first time in a computer it needs to be registered. This will probably already be done for you when you get the laptops, but if any major update needs to be done you will have to register it again.

To register ICM+ you need to press the Registration button on the Home tab.



This will bring up the Detailed ICM+ License Info window where you will need to press the Register New Key button.



This will bring forth the ICM+ Registration Form.

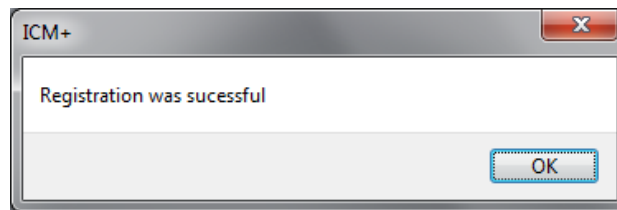
 A screenshot of the 'ICM+ REGISTRATION FORM'. The form contains the following fields:

- InstallCode:** 905F4BC6C299 (highlighted in yellow, with a green arrow pointing to it from the left)
- Username:** peter
- Institution:** University of Cambridge
- Computer:** HEX

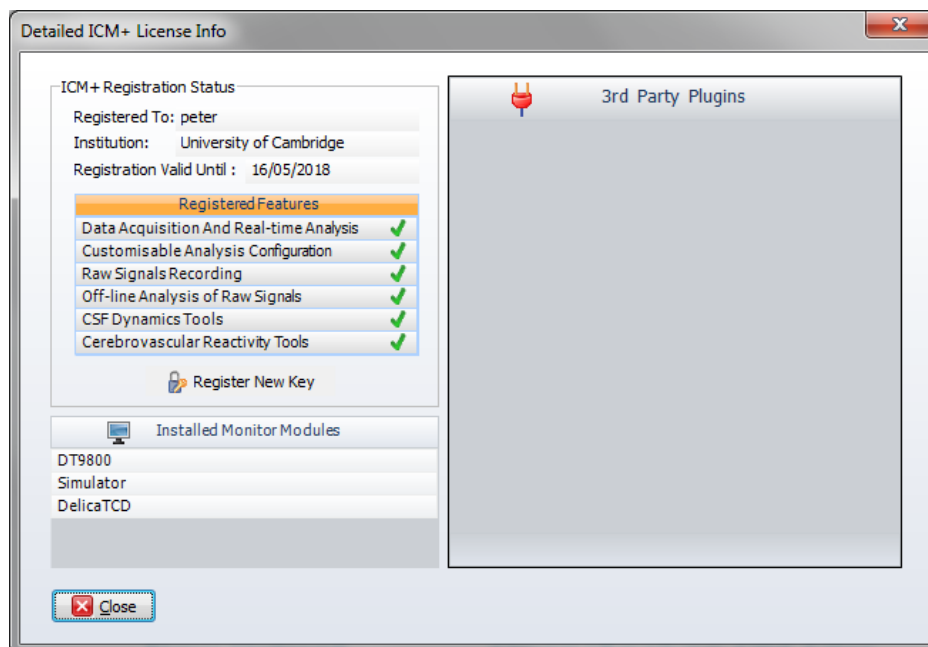
 Below the fields are two buttons: 'Copy Details' (highlighted with a blue border and a green arrow pointing to it from the left) and 'Email Details'. At the bottom of the form is a 'Register Now' section with a text input field and a 'Register Now' button (highlighted with a blue border and a green arrow pointing to it from the left). Other buttons at the bottom are 'Cancel' and 'Keyboard'.

Using Copy Details button one can then copy the registration details to paste into an email and send to ps10011@cam.ac.uk with a request to generate a key. The Email Details is a shortcut for this when the computer is networked.

Once the key is received it needs to be pasted into the highlighted space and Register now button clicked upon which the registration successful dialogue should appear.

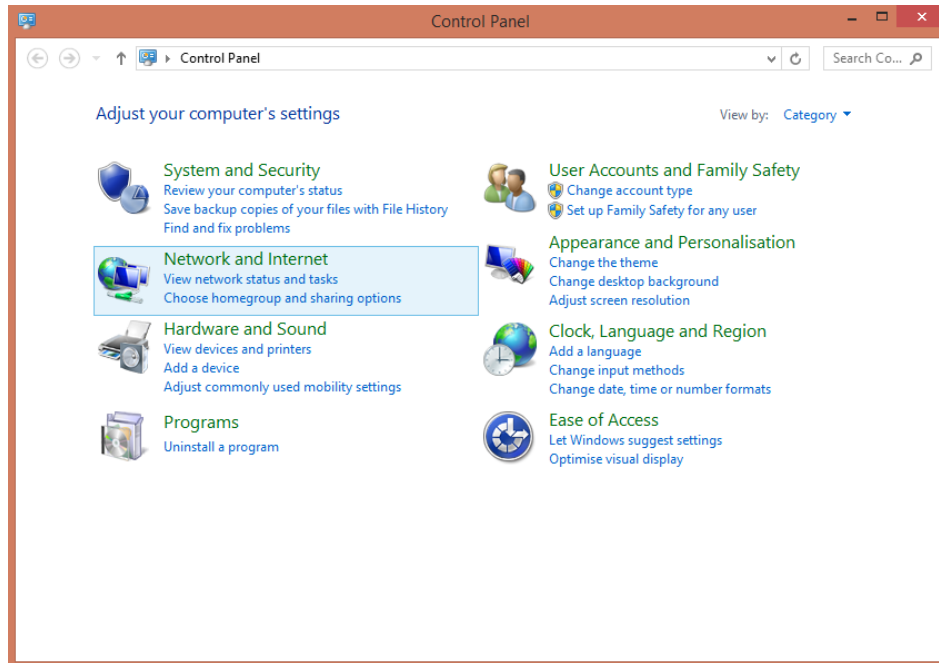


And the Detailed ICM+ License Info window should now look like this:

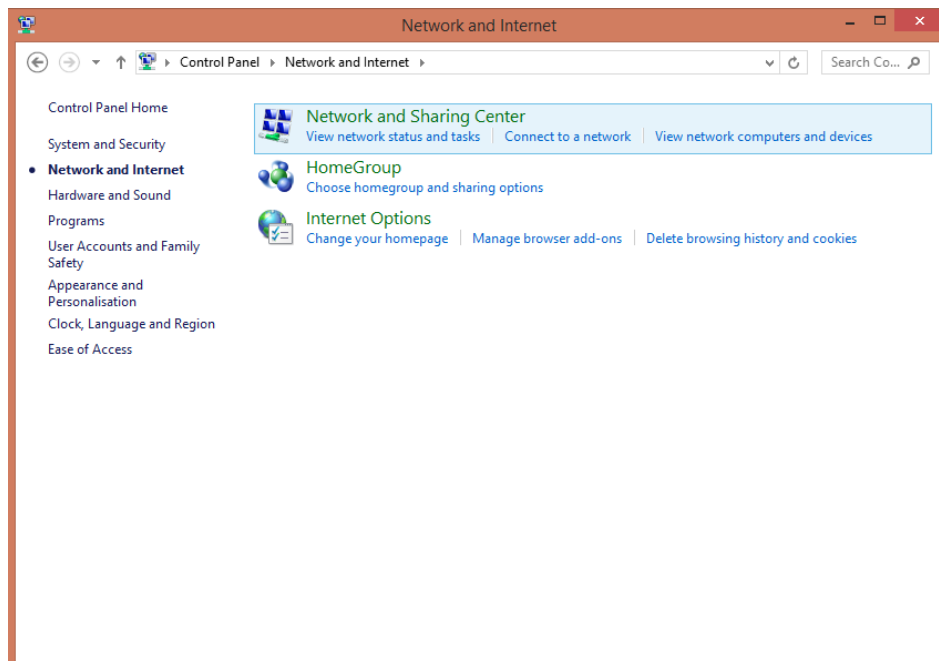


Appendix 5: Configuring the computer's network interface

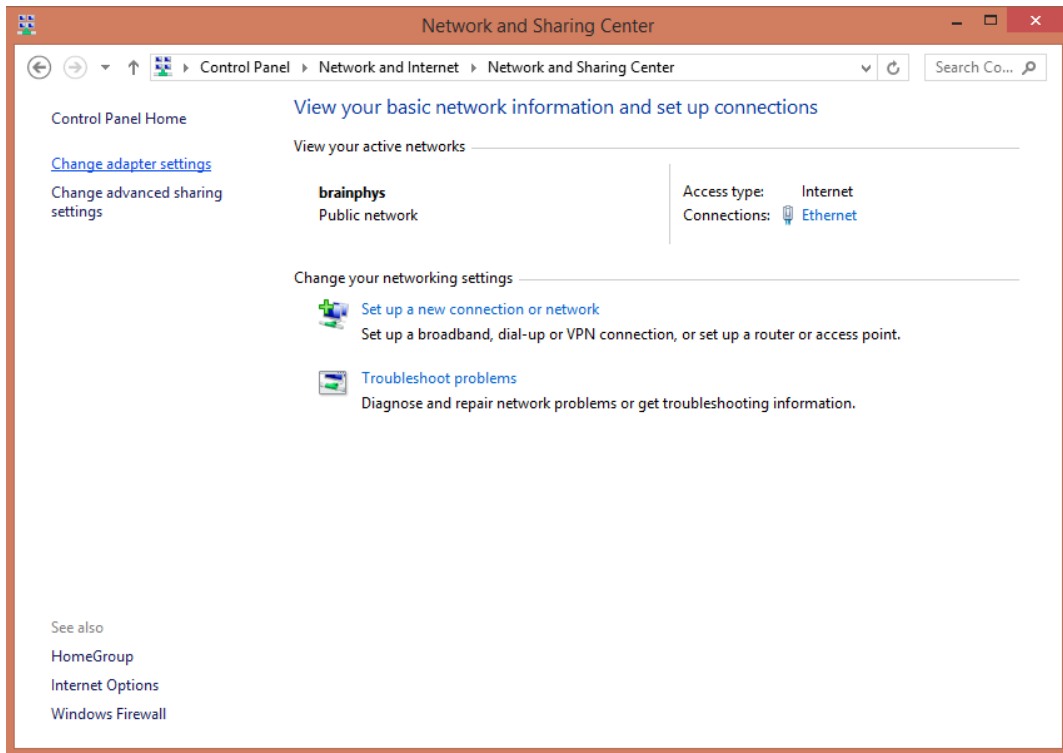
To configure the Network of your Computer you need to open the Control Panel and click on the **'Network and Internet'** button.



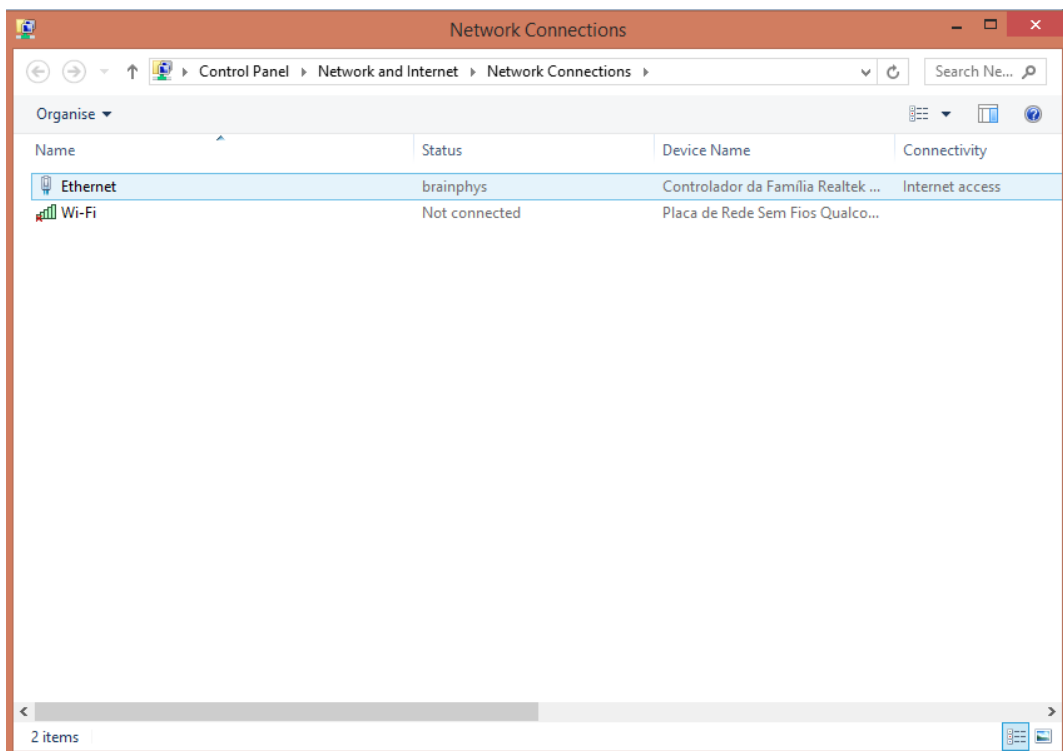
In the new window that will open click on the **'Network and Sharing Center'**



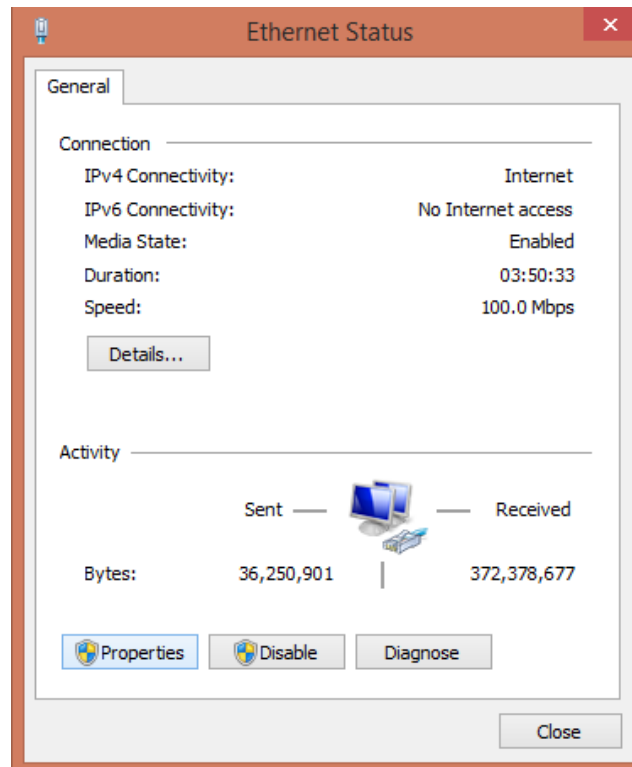
In the new window that will open click on the '**Change Adapter Settings**'



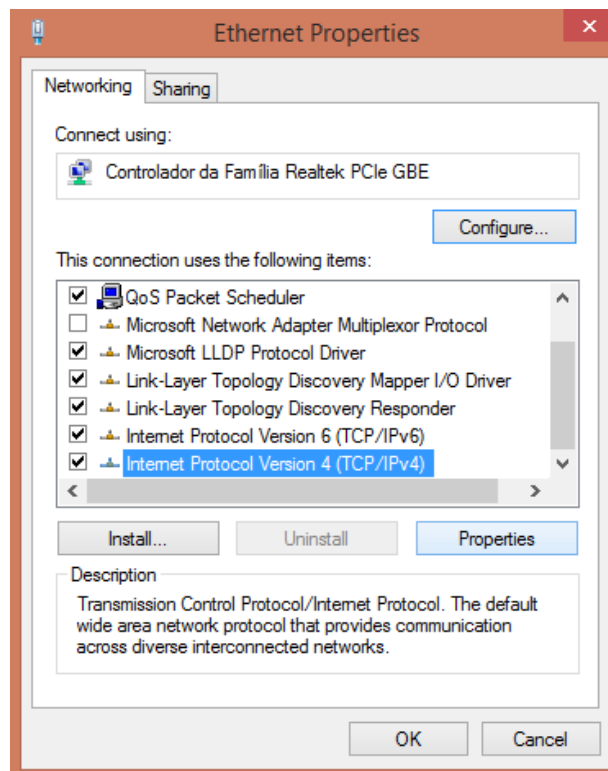
In the new window that will open click on the '**Ethernet**'



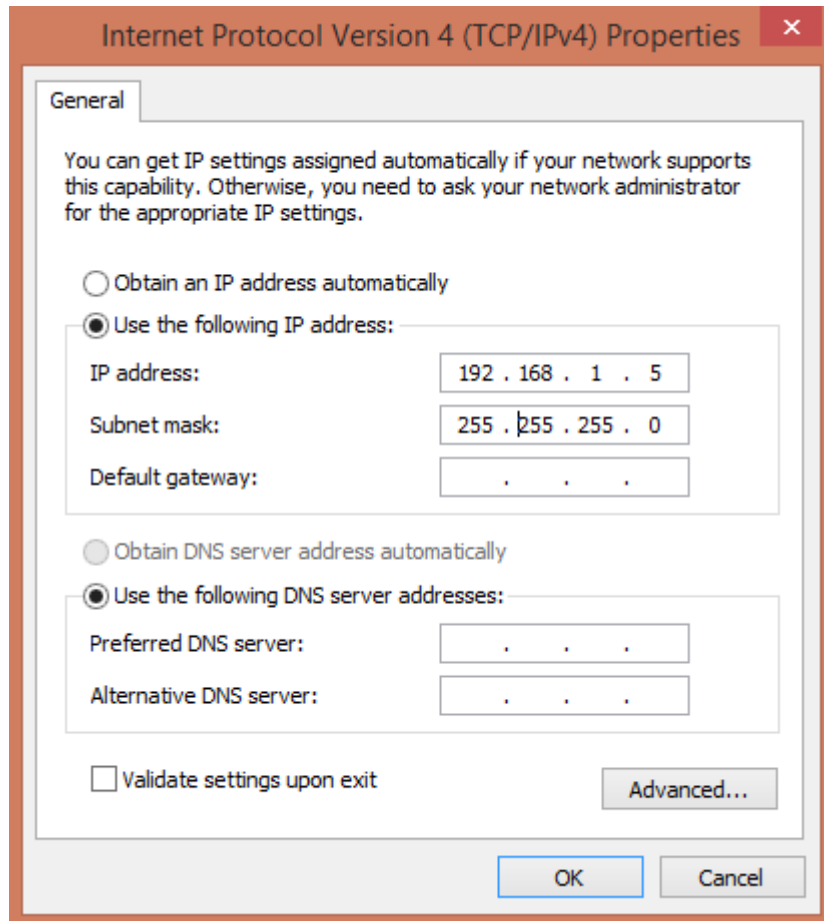
In the new window that will open click on the **'Properties'**



In the new window that will open click on the **'Internet Protocol Version 4 (TCP/IPv4)'** and on properties.



In the new window that will open insert the new IP address that your machine will be using. This has to match the Delica network subnet settings (which are configured in exactly the same way on the Delica computer), only the IP address has to be different, and for example with Delica monitor configured with IP address 192.168.1.4, the ICM+ laptop should be configured as in the figure below.



Appendix 6: Preconfigured users and passwords

Administrator – 2718

Manager – 1618

Operator – 3142

Nurse – 1414

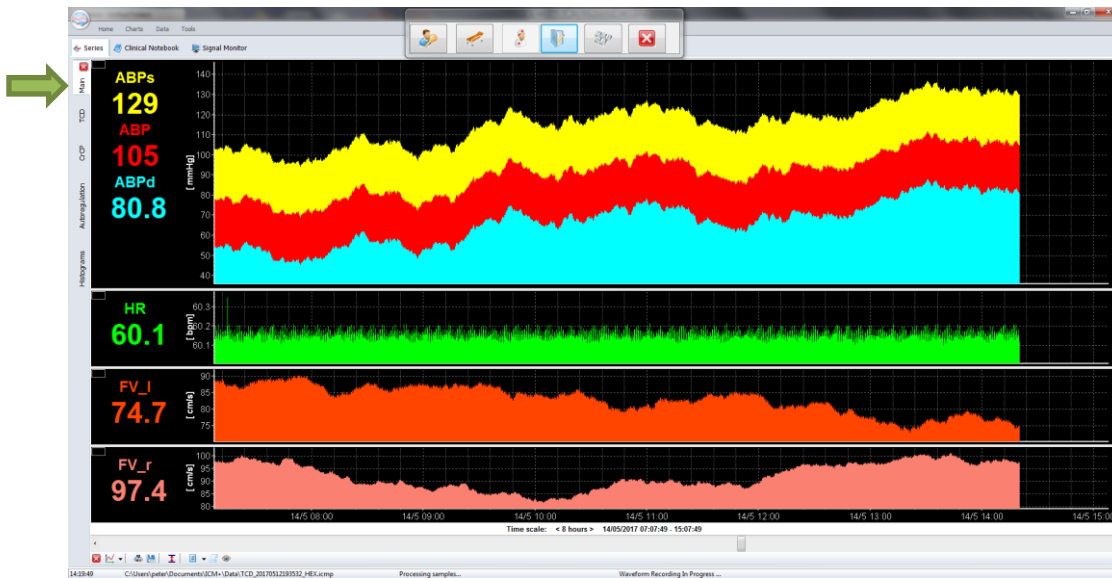
The users, their passwords, and their rights are fully configurable in the software, using Users form. The default users have been chosen to fulfil the following roles:

User	Role
Administrator	Complete access to all the software configuration options, the users and passwords
Manager	Access to all the configuration options, except the users and password. This will normally be the user to do the entire configuration needed for data collection.
Operator	Control of the data collection process using preconfigured profiles, and changes to the charts layout and properties.
Nurse	Access to clinical annotations tools only. This should be normally set up as the default user kept logged-in during the data collection process, in order to prevent any inadvertent disruption to data recording but at the same time allowing and encouraging quick access to the clinical annotations.
Guest	This 'user' has no rights, making it impossible to interact with the software in any way.

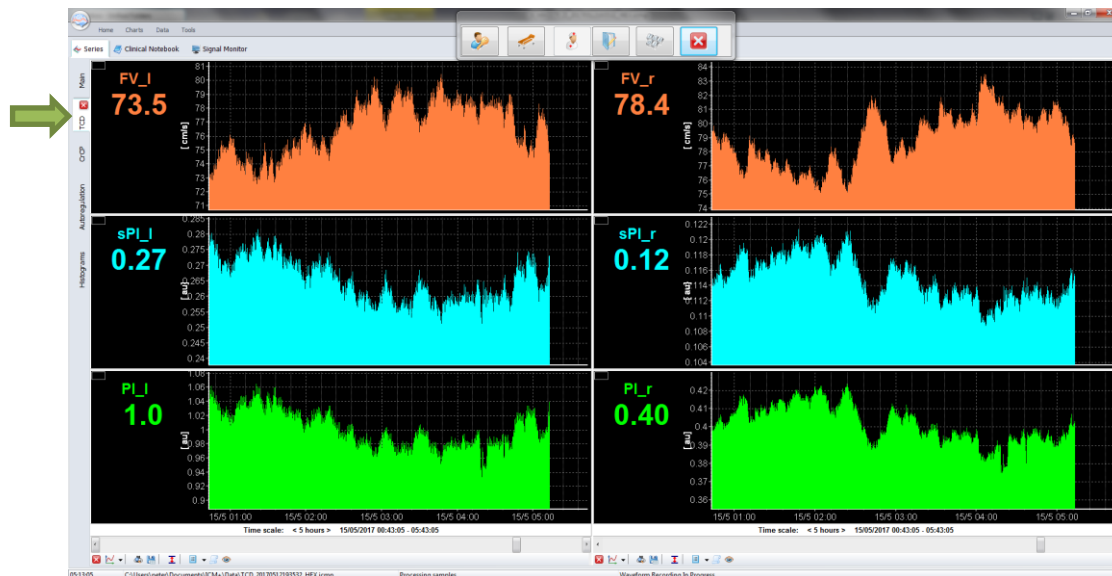
Appendix 7: Default configurations profile

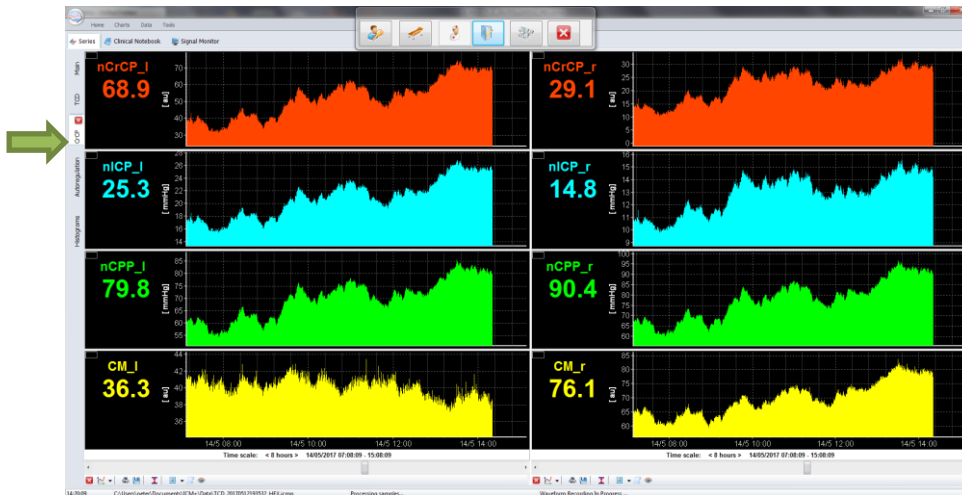
With the dedicated Delica TCD version of ICM+ a default configuration profile for collection and analysis of both TCD and arterial blood pressure has been provided. All the parameters are calculated once every 10sec. The display of these parameters is organised into several pages, which can be navigated using a set of tabs organised vertically on the left side of the charts.

The pages have been configured to show:



Main tab: trends of the arterial blood pressure measurements, pulse rate and mean flow velocities.





CrCP tab: Bilateral trends of the critical closing pressure and non-invasive ICP estimations



Autoregulation: Bilateral trends of measures of cerebral autoregulation



Histograms tab: presents arterial blood pressure and blood flow velocities in the forms of histograms

The following table contains explanation of all the parameters configured. Suffixes ‘_l’ (indicating left side) and ‘_r’ (indicating right side) have been removed for clarity and brevity:

Parameter	Units	Description
ABP	mmHg	Mean arterial blood pressure
HR	bpm	Heart rate
ABPs	mmHg	Systolic arterial blood pressure
ABPd	mmHg	Diastolic arterial blood pressure
FV	cm/s	Blood flow velocity mean
Mx	-	Mean autoregulation index
FVd	cm/s	Flow velocity diastolic
PhShft	Deg	Phase shift in the very low frequency band (0.008-0.05Hz) of FV response to ABP
Coh	-	Mean coherence in the very low frequency band (0.008-0.05Hz) of FV response to ABP
CVR	mmHg*s/cm	Cerebrovascular resistance
Ca	cm/mmHg	Cerebral arterial compliance
sPI	-	Spectral pulsatility index (fundamental spectral amplitude / mean)
PI	-	Goesling pulsatility index (peak-to-peak amplitude / mean)
nICP	mmHg	Non-invasive ICP
nCrCP	mmHg	Critical closing pressure
nCPP	mmHg	Non-invasive CPP
CM	mmHg	Vascular closing pressure margin

Appendix 8: Selected relevant references

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