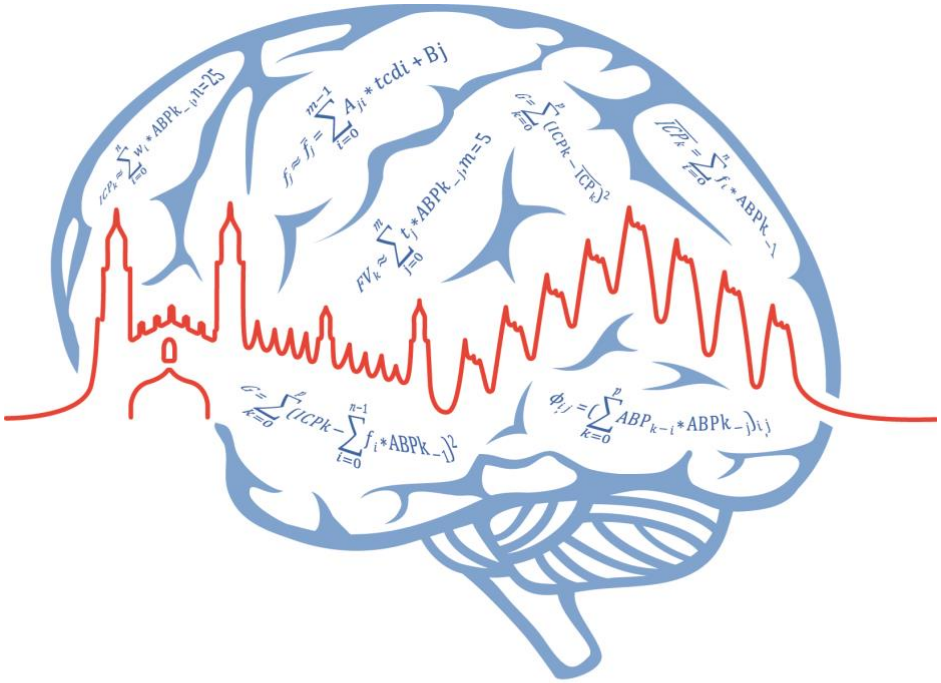
ICM+ Standard of Procedures



ICM+®

INVOS monitor

28 April 2020

https://icmplus.neurosurg.cam.ac.uk

Table of Contents

Prerequisites

1. **A laptop (or a PC) with the latest ICM+** and INVOS module installed

2. **INVOS monitor**

Figure 5-1 Back Connections and Elements

1. Digital Output Port
2. VGA Output Port
3. Potential Equalization (Grounding Post) Connector
4. Alarm Speaker and Cooling Fan
5. Fuse
6. AC Mains (Master) Power Switch
7. AC Input, Power Cord Connector
8. Serial Number SN

3. **Appropriate cables**:

   Connection with ICM+ laptop is via port 1 (above) and a null modem Serial-USB cable, like this:

   https://www.startech.com/uk/Cards-Adapters/Serial-Cards-Adapters/USB-to-Null-Modem-RS232-DB9-Serial-Adapter-Cable-DCE-FTDI~ICUSB232FTN

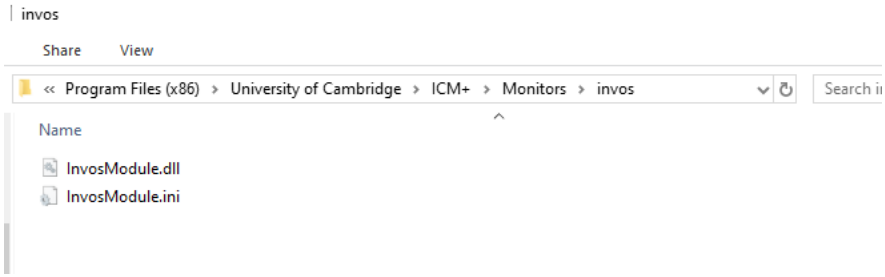
4. **Make sure the Output format setting in INVOS monitor matches the setting of the ICM+ module:**

Once the INVOS System components and the external device are connected, the INVOS Monitor is ON and in Run Function, press the HOME key to display the Main Screen and follow these navigation bar options to begin interfacing:

BASELINE MENU	EVENT MARK	ALARM AUDIO ON/OFF	**NEXT MENU**
OUTPUT SELECT	USER CONFIGURATION	TIME SCALE	PREVIOUS MENU
USB	**DIGITAL OUTPUT**		PREVIOUS MENU
PC LINK	PHILIPS	PREVIOUS MENU	MAIN MENU
CASE HISTORY	**OUTPUT FORMAT**	PREVIOUS MENU	MAIN MENU
OUTPUT FORMAT 1	**OUTPUT FORMAT 2**		PREVIOUS MENU

Select **OUTPUT FORMAT 1** or **OUTPUT FORMAT 2**.

ICM Module settings are defined in InvosModule.ini file:



Set the setting DigitalOutputFormat to match the number of the Output Format in INVOS setting above, eg:

DigitalOutputFormat=1

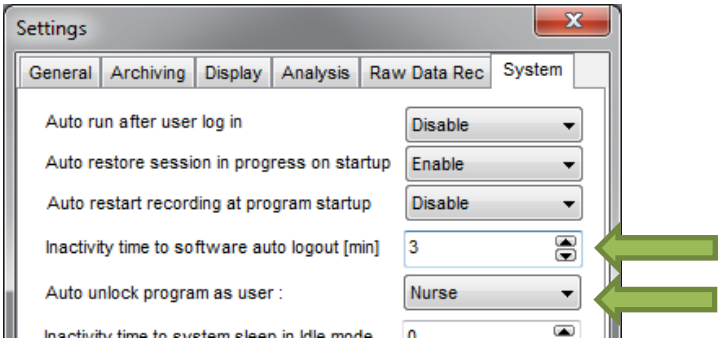
(Format 1 is the default setting in the ICM+ module)

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**.

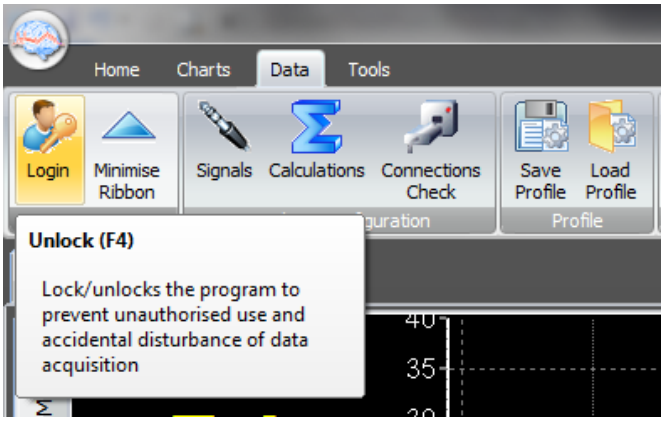


The **Administrator** is the user that will have full access to the full features of the application.

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

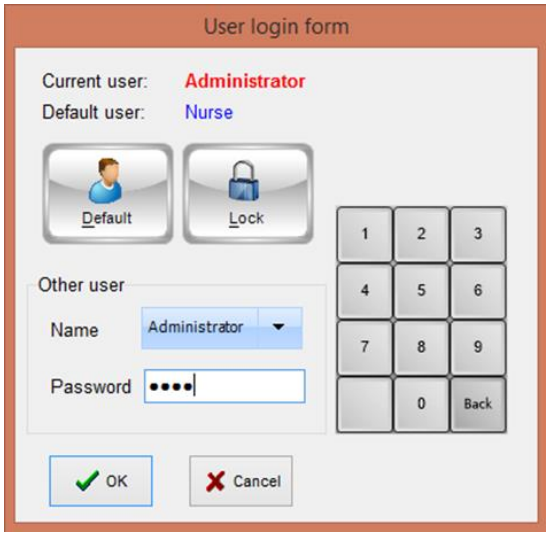
The **Operator** will only be capable of starting new Recording sessions with available profiles, browsing data, inserting clinical information and display configuration.

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.

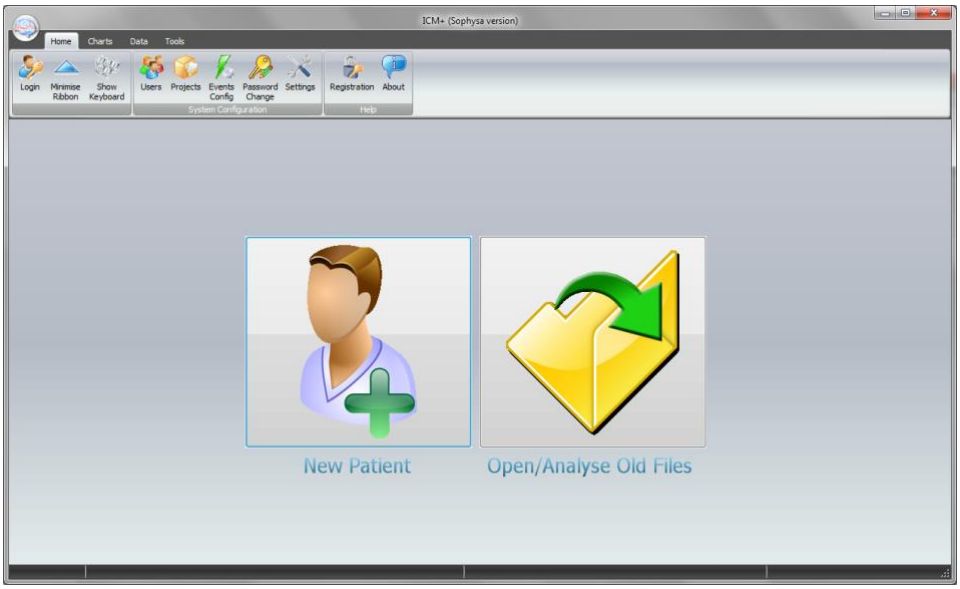


In this form you will find:

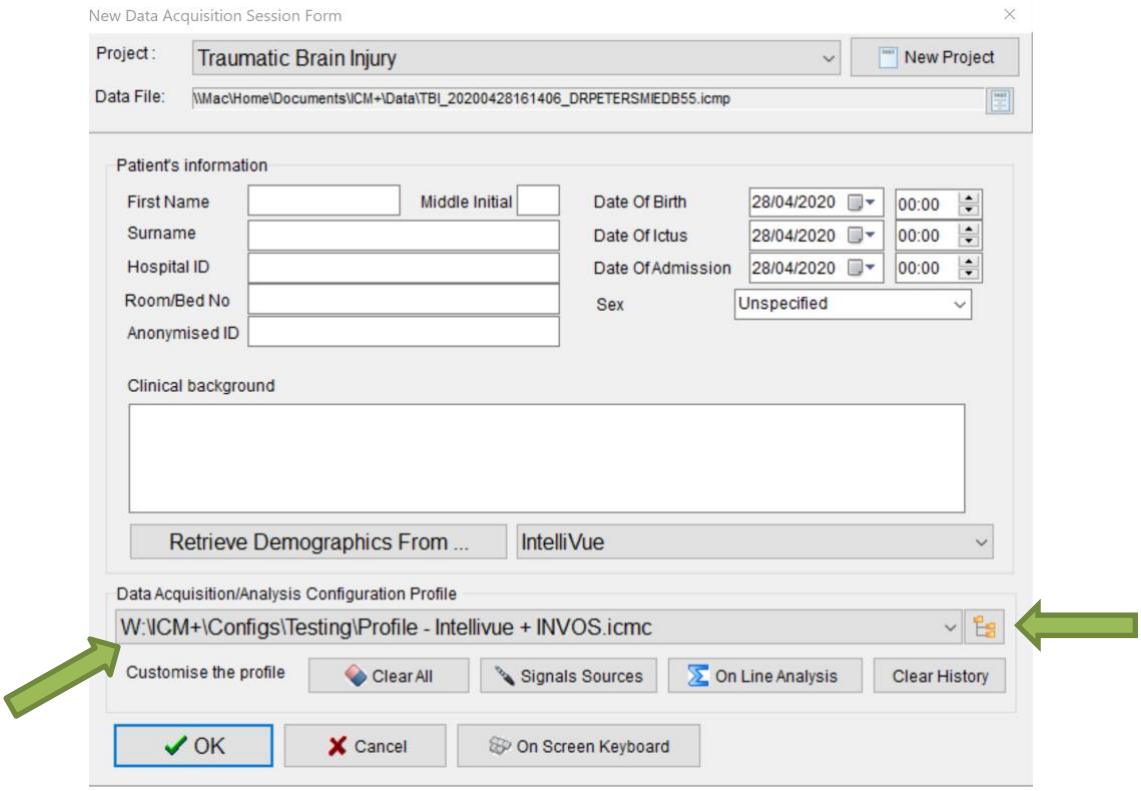
1. A button to the Default user and a button to lock the application so that nothing but the login button is accessible.
2. A key pad to insert the Password for a given use.
3. And a Drop-Down menu to select the user to login as.

Starting a new data collection session

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

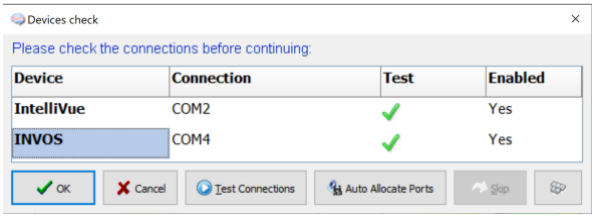


This will bring up a new form, where patient details can be entered:



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.

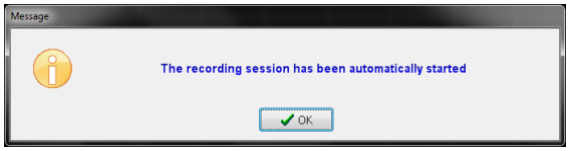


This dialogue is used to test the communication between the ICM+ and the monitor (the 'Test connections' button). If the test is successful the OK button can be pressed.

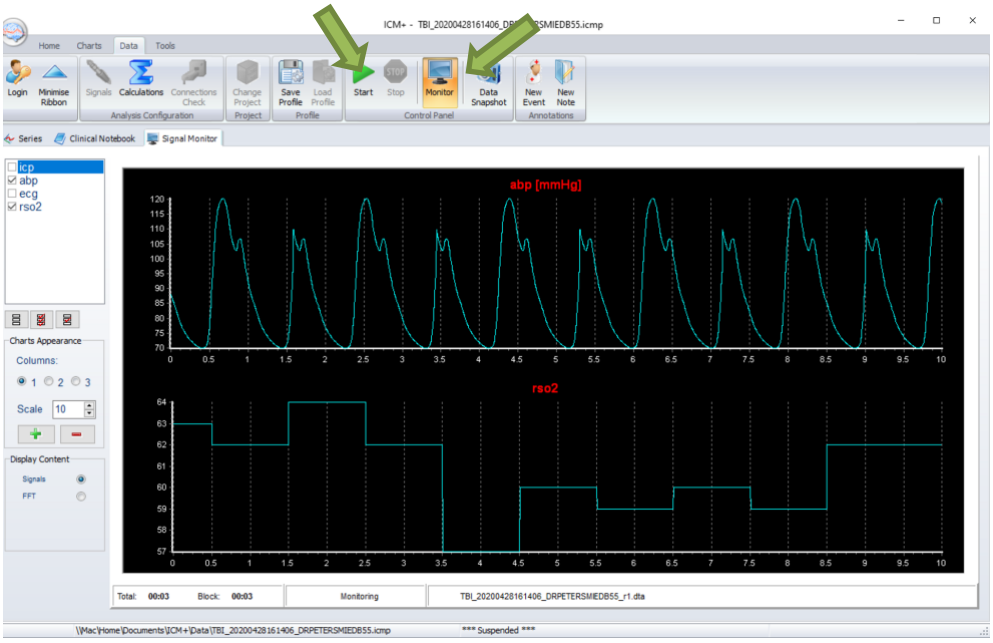
This menu can also be used to select the right connection, whether it is a serial connection (like the one presented in the picture) or an IP address. In the case of a serial port connection, the button auto allocate ports can be pressed and the application will search for the right port.

If the 'Auto start recording at New Session' option is selected in the settings ICM+ connection to the monitor will be tested automatically and the dialog will close after the test. If the test initially fails different serial (COM) ports available in the computer should be tried and 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).

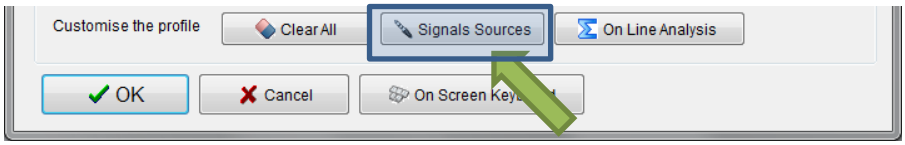


If ICM+ **shuts down during a recording session** the next time it is run, the previous session is automatically restored, but here the user must first verify that all the signals are being received correctly in the Monitor button. After this the Start button must be pressed and the session resumes recording.

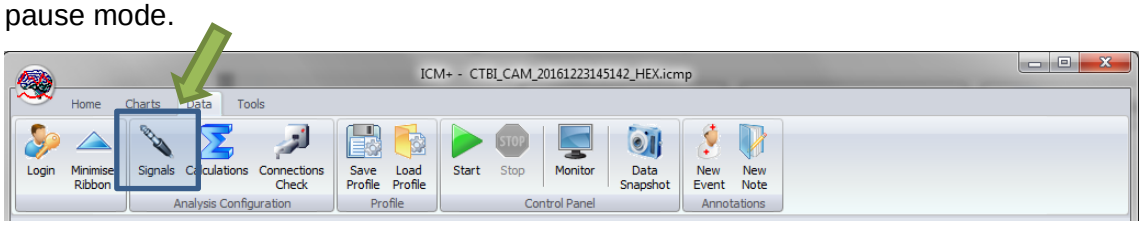


Manually configuring data collection

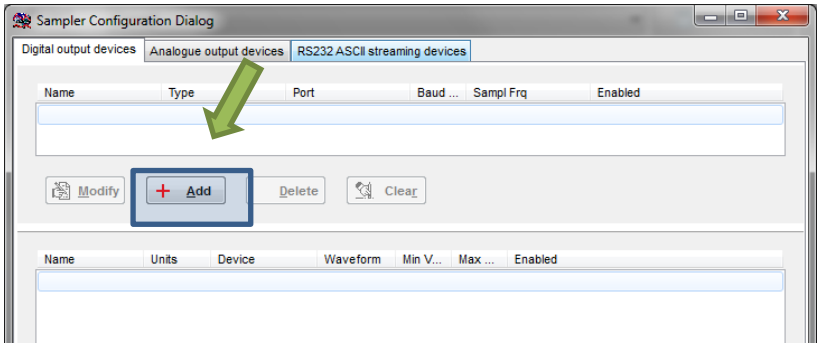
If there is no prepared profile available that includes desired data collection from the monitor or if there is a need to modify or add parameters downloaded from the monitor Signal Sources option needs to be used. This can be done in the New Data Acquisition Form:



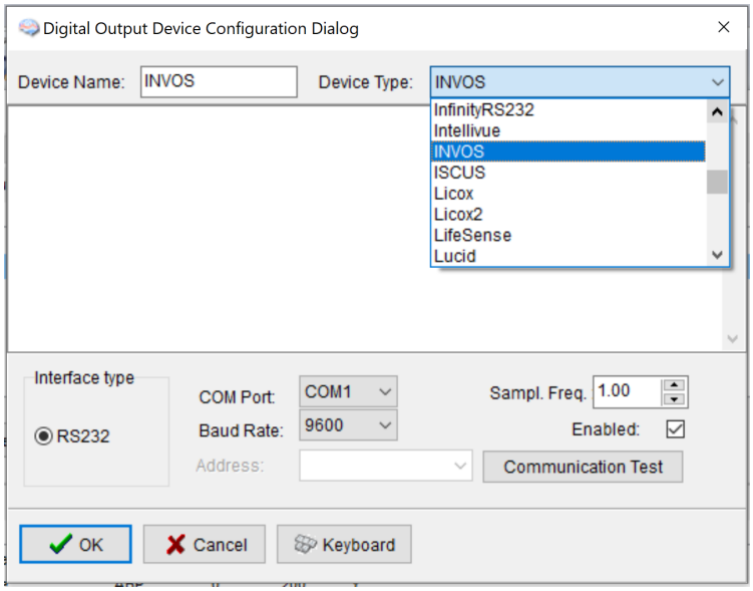
Or using Signals button in the main Menu (Data Section), with the data acquisition in pause mode.



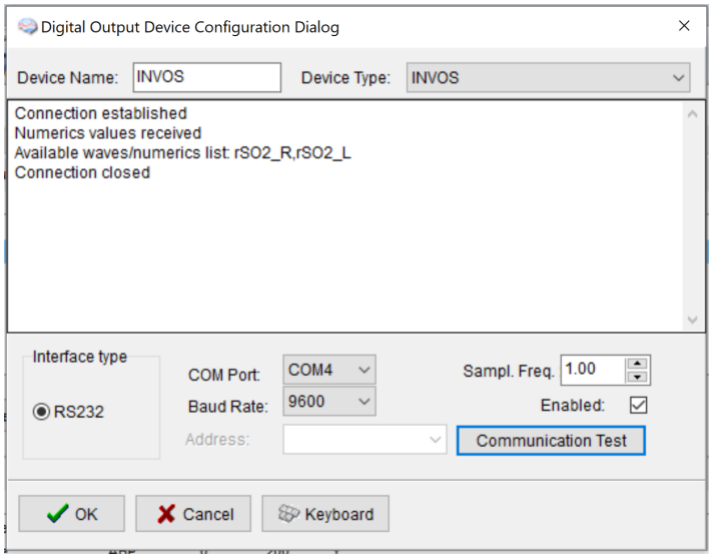
This brings up the Sampler Configuration form:



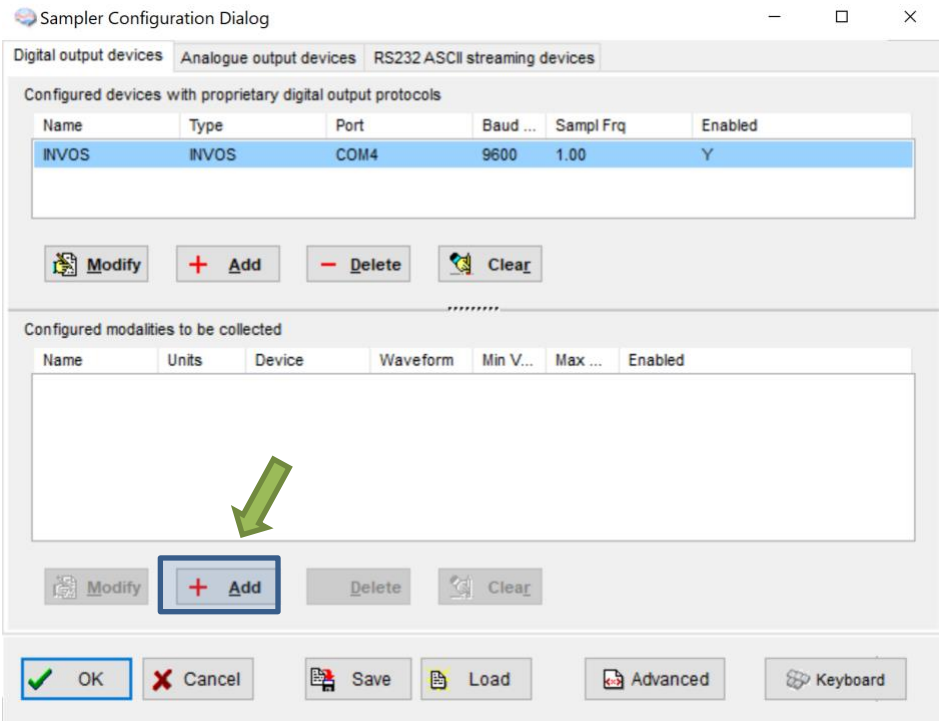
Clicking on Add button in the upper part (Digital Output devices tab) opens a Device Configuration dialog. Here, one can select the monitor module from the list of available (installed) interfaces, as well as specify the serial port (real or virtual, when using USB-RS232 adapter) and its baud rate to match the one configured/offered by the device.



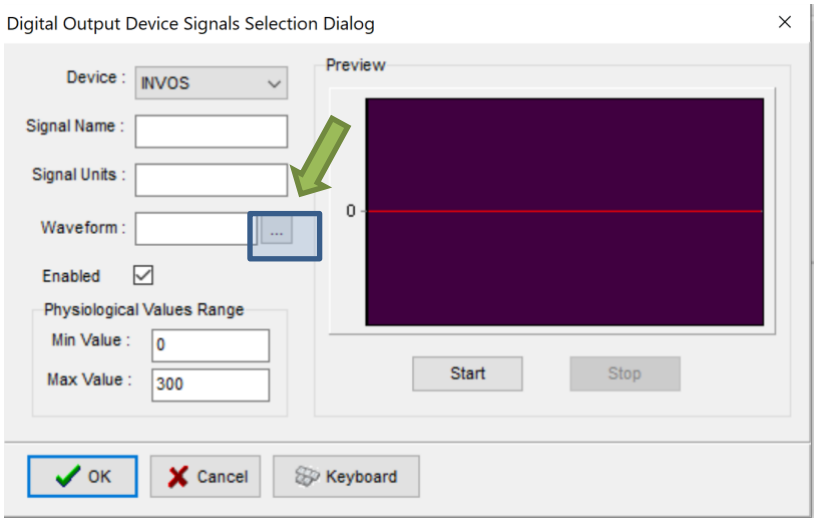
When the correct interface module is chosen (INVOS), clicking on ‘Communication Test’ will try to establish communication with the monitor and the log of that communication is printed in the memo box, listing also all the parameters that are available to download from the monitor.



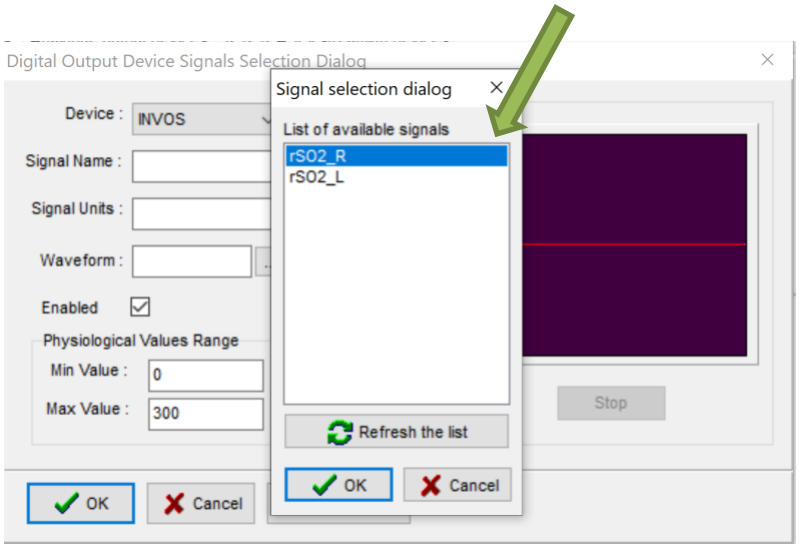
When the connectivity is confirmed the dialog can now be closed, which causes the device to be added to the data collection configuration. What remains to complete the configuration is adding to the configuration all the desired parameters to be downloaded. This can be achieved by using the Add button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



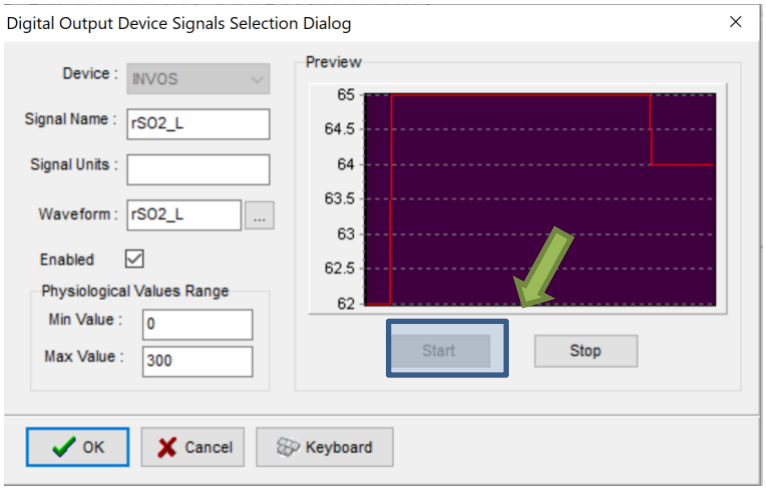
This opens a signal selection dialog:



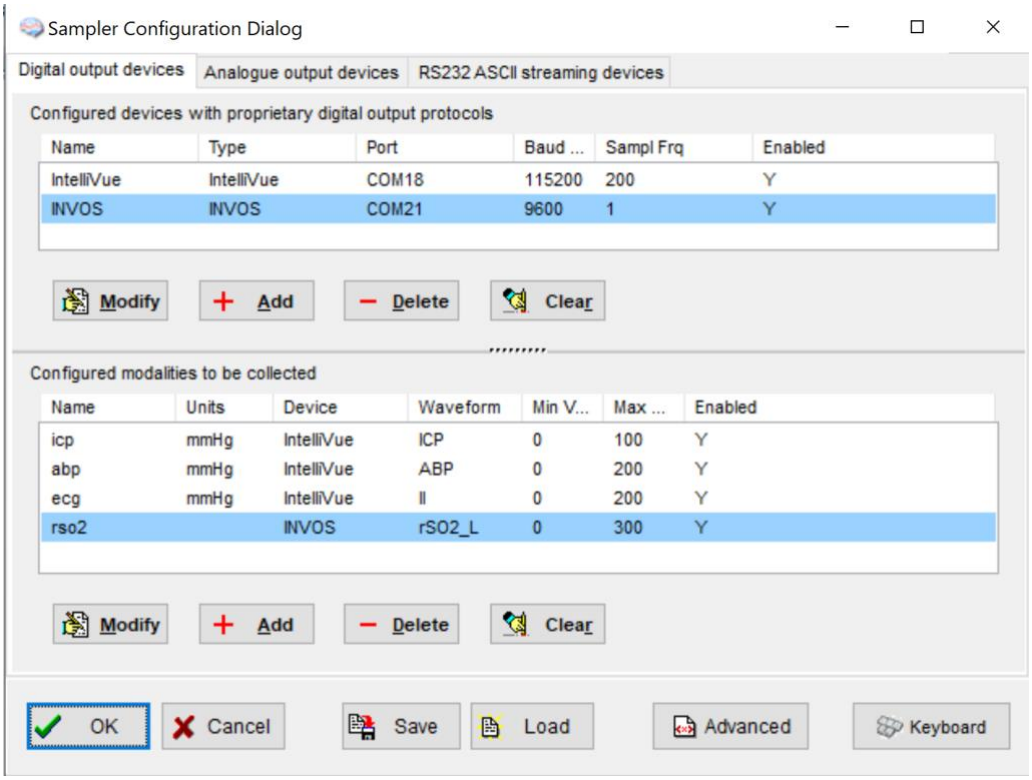
Using the little '…' button one can select available signal, one at a time



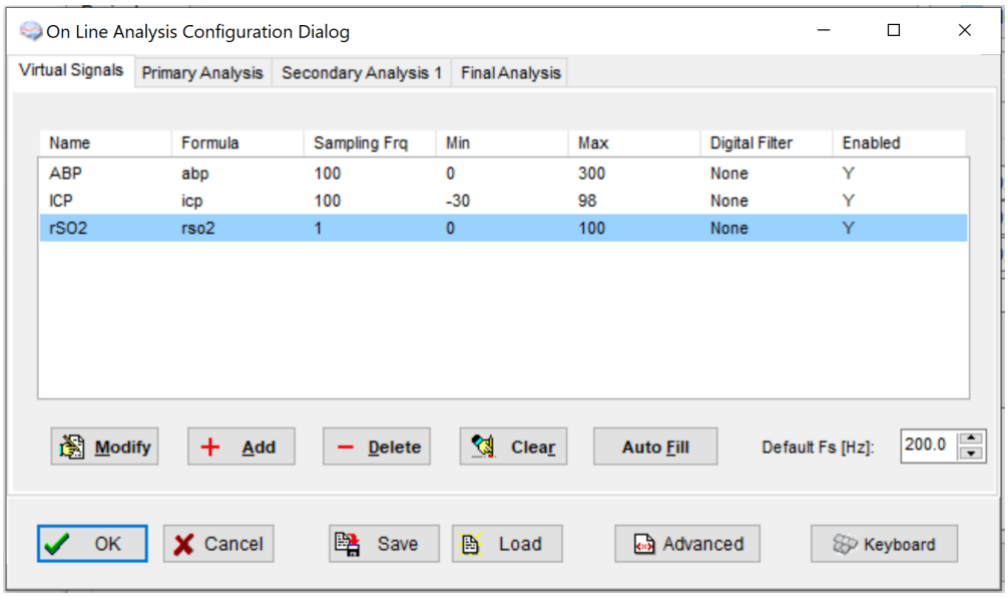
When a parameter is selected one can test if the data is coming in as expected by using the Start button.



This process can be repeated as many times as it is needed putting together the complete list of parameters to be collected (also adding other devices), 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.

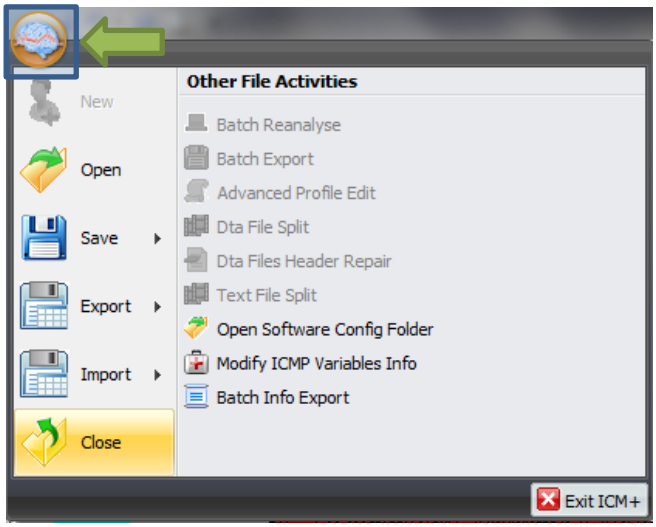
There, from left to right the following functions are accessible:

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

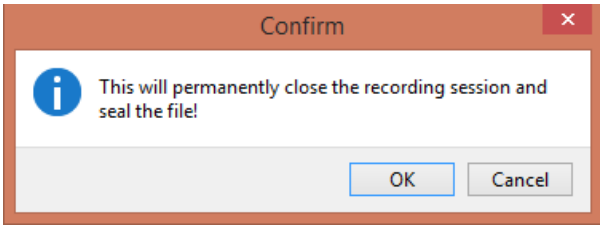
Terminating the data collection session and archiving the data

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.

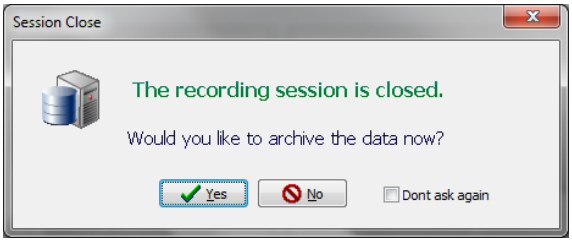
Closing a session is different from closing the program. To close the ICM+ application you need to press the red cross present on the upside corner of the right side of the screen. If ICM+ is closed (Exited) using this button or if the computer shuts down, the next time it is run, the recording session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



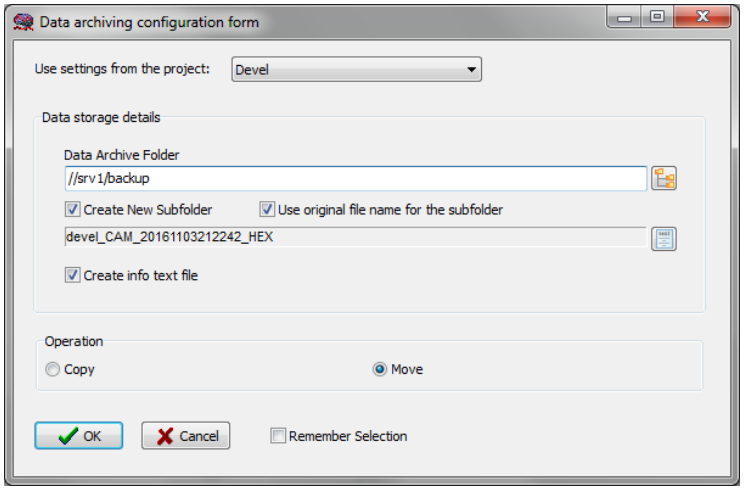
When this button is pressed a dialogue is presented prompting the user to confirm the closure of the recording session:



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

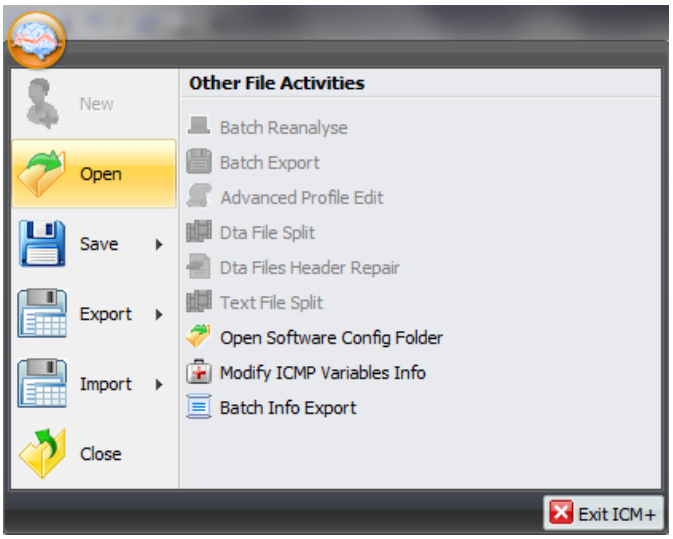


After confirming this dialogue the Data Archiving Form is presented, where the user can specify/confirm the location of the server and its share to use:

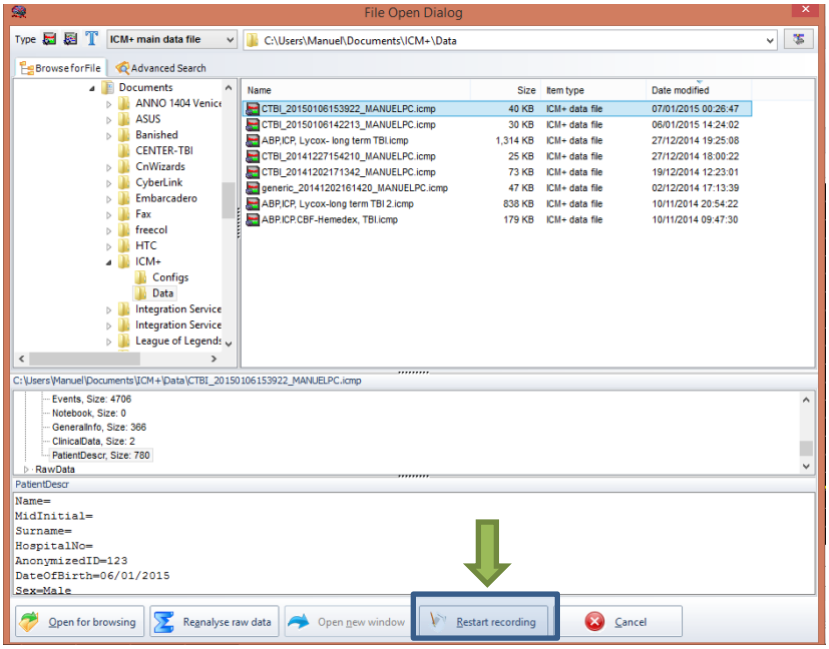


Restoring a closed data collection session

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.

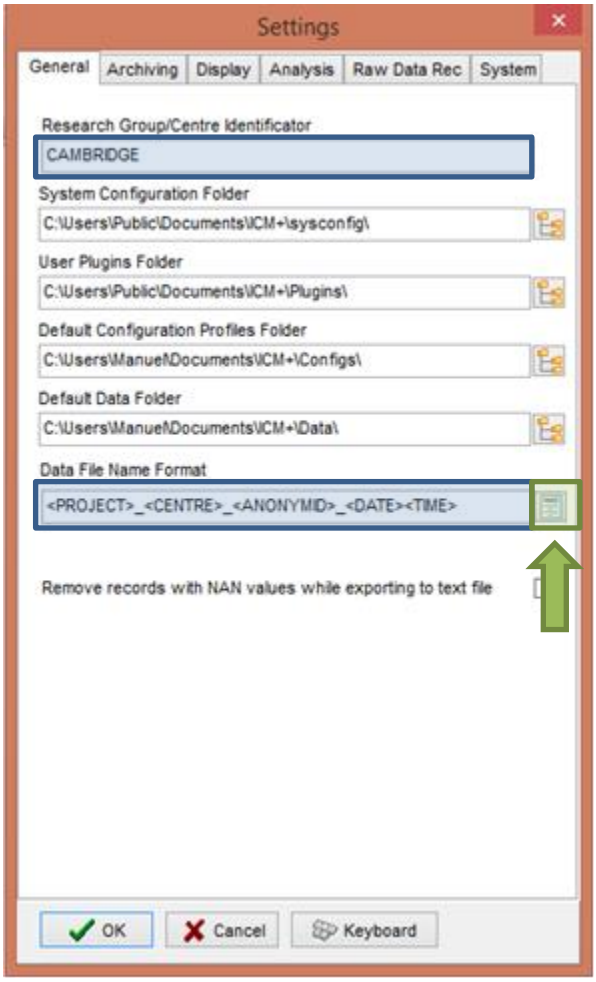
To restore the recording session, the highlighted button must be pressed and the recording resumes using the same profile as when it was closed.

Appendix 1: Configuring ICM+ system options

Most of the programmable behaviours of the software can 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:

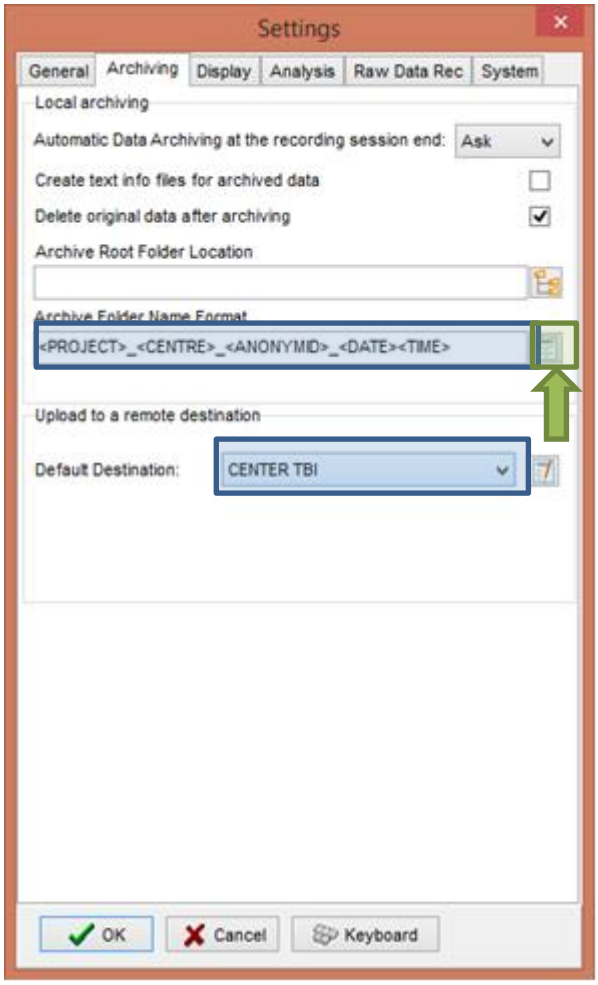
- On the General tab:



  - 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.

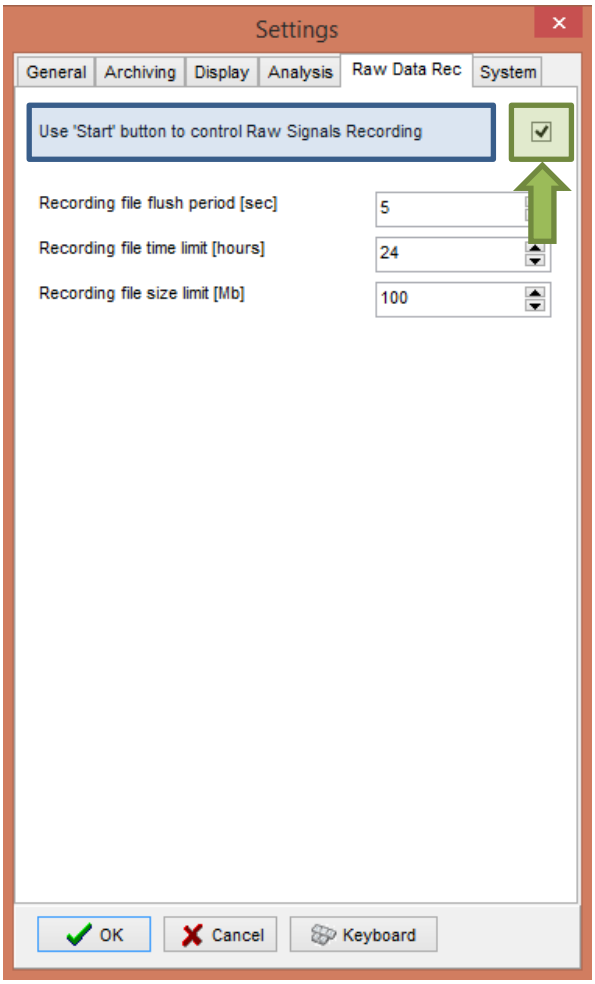
- On the Archiving tab:



  - 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.

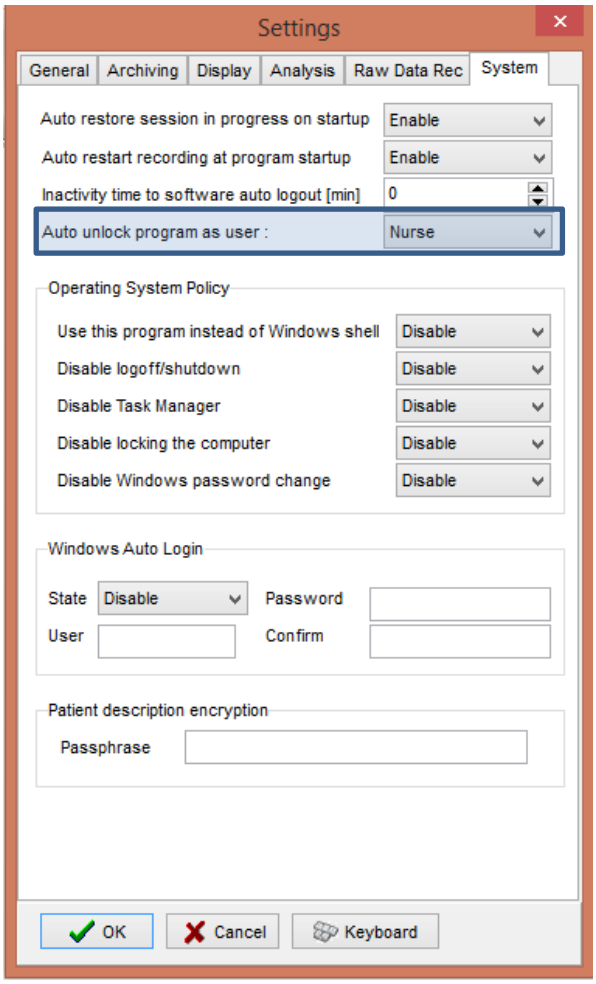
  - The remote server Upload (accessible via the upload function) default Destination can be selected here but it is the matching setting in the Project configuration that will ultimately take precedence.

- On the Raw Data Rec tab:



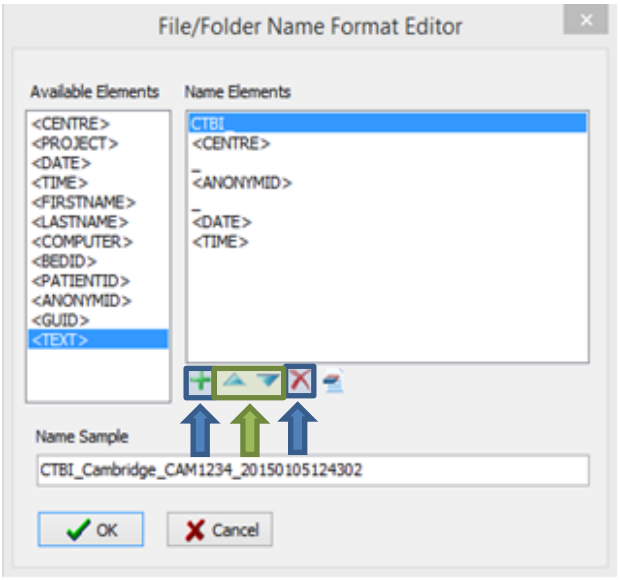
  - The Use ‘Start’ button to control Raw Signals Recording **must be checked if you are using ICM+ to record any data directly from bed side monitors**

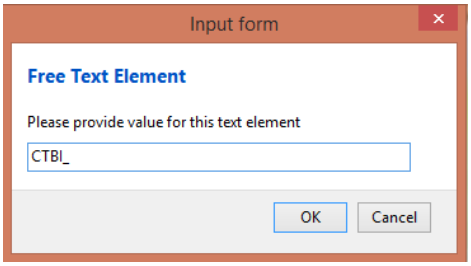
- On the System tab:



  - 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\<username>\Documents\ICM+**.

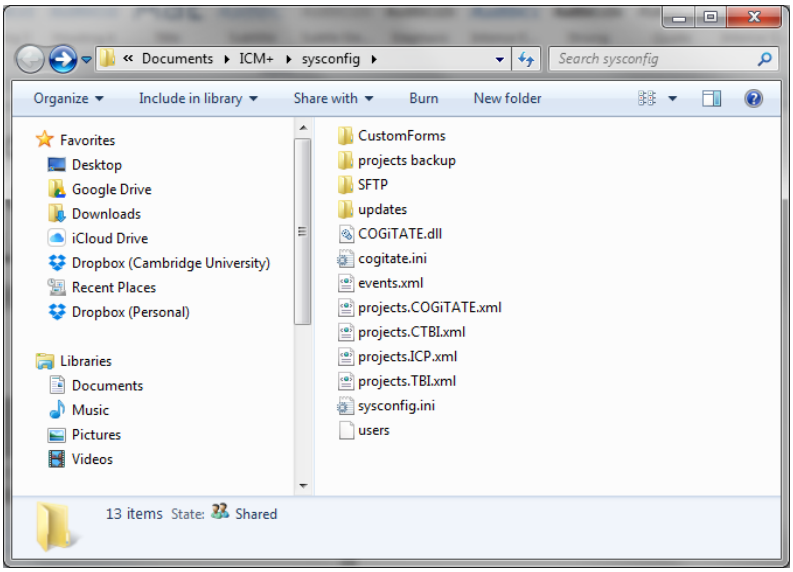
There are two subfolders here:

'**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.

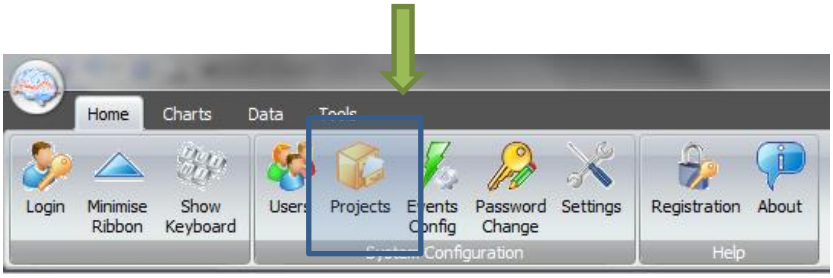
Location 2: **C:\Users\Public\Documents\ICM+**

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.

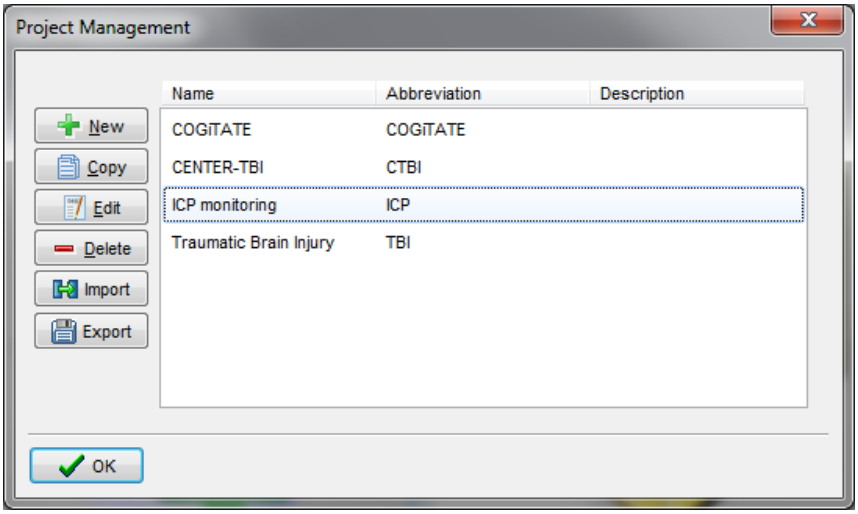


Appendix 3: Editing ICM+ Projects

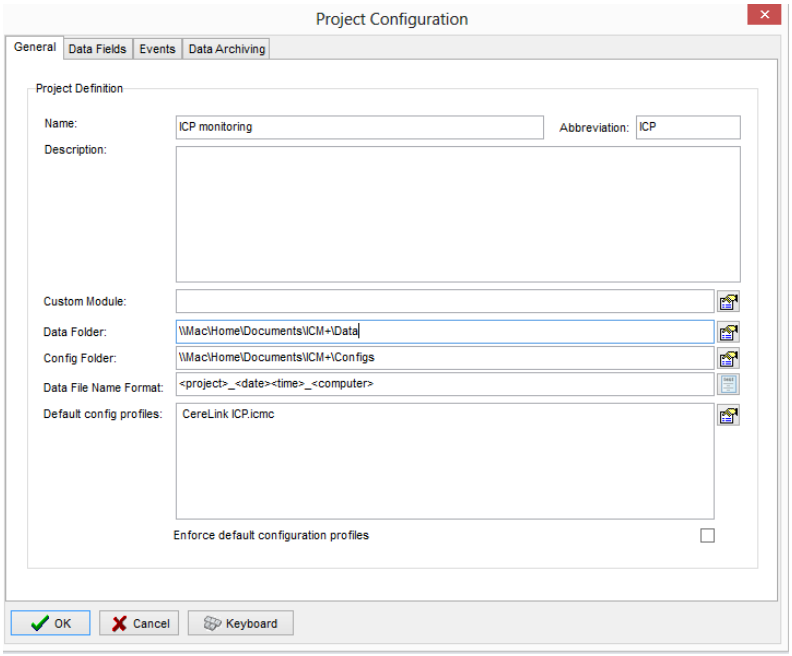
Projects contain various configurations specific to a particular research project. These can be edited using **Projects** button in the main menu tool bar.



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.



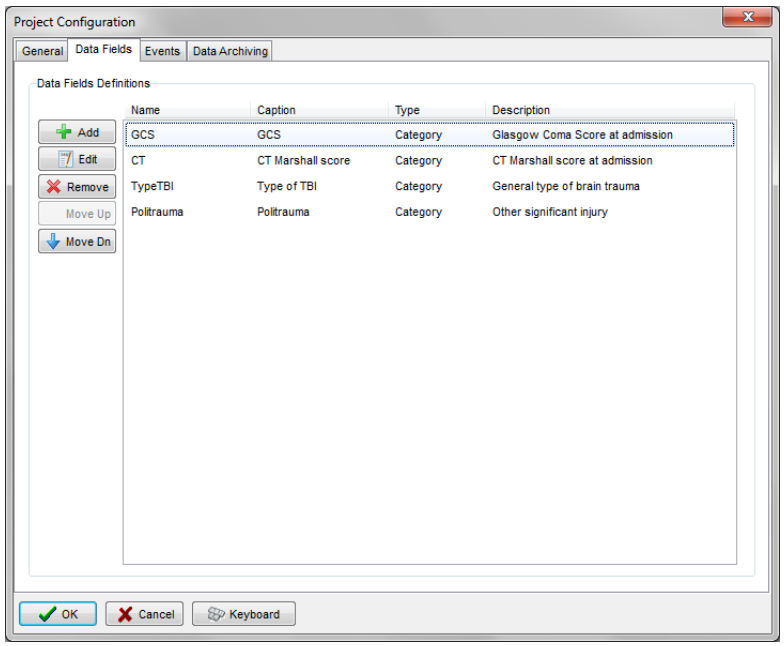
1 . The project **abbreviation** will be part of the file name

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

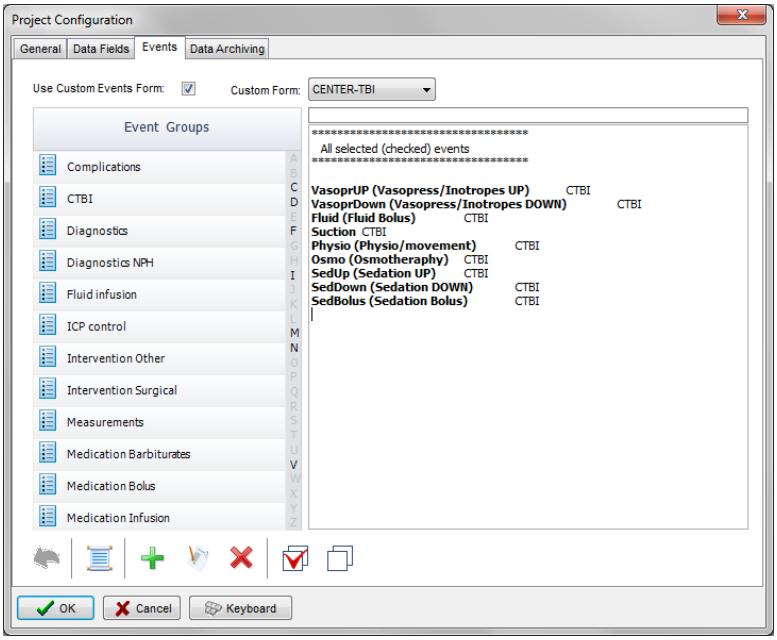
3. '**Config Folder'** is a folder (could be a network share) where the data configuration profiles are kept

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.

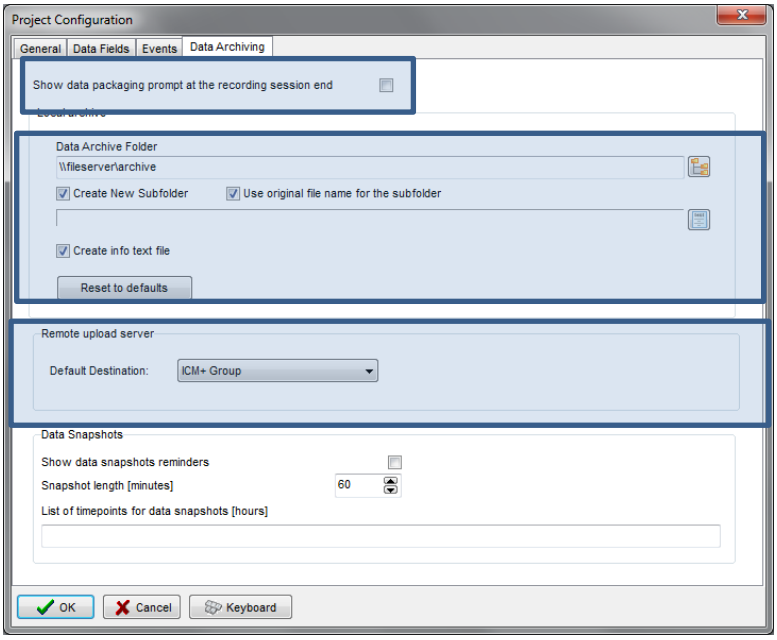


The data fields define placeholders for general clinical descriptors that characterise the patient at the time of admission to the critical care unit, that are useful to be kept together with the monitoring data.



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,

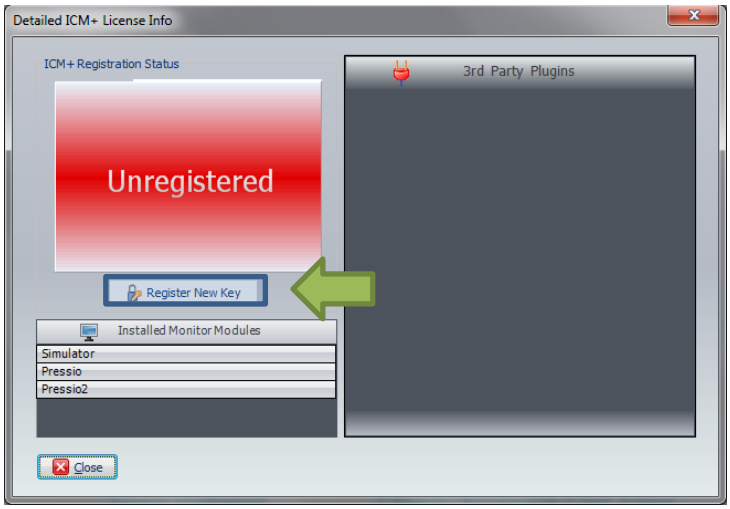
3. the destination of a remote SFTP upload data server , configured in the Settings, and facilitating multicentre data collection projects

Appendix 4: Registering ICM+

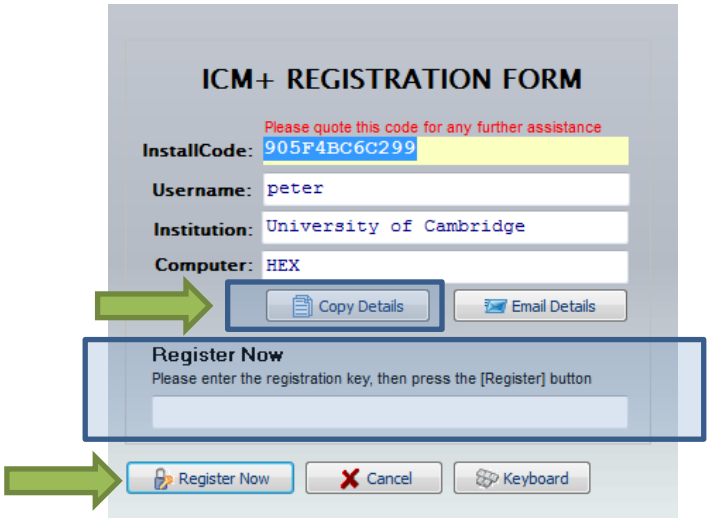
When ICM+ is successfully installed for the first time in a computer it needs to be registered. This will probably already be done for you when you get the laptops, but if any major update needs to be done you will have to register it again.

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.

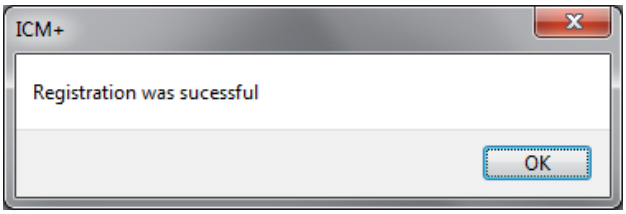


This will bring forth the ICM+ Registration Form.

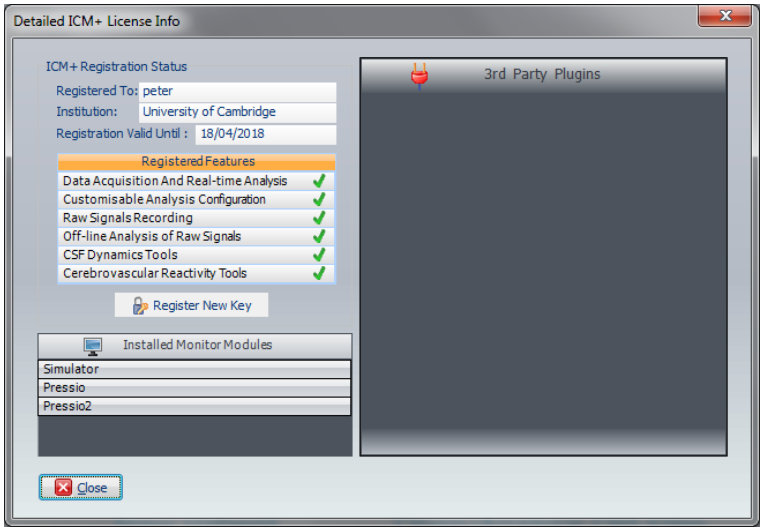


Using Copy Details button one can then copy the registration details to paste into an email and send to ps10011@cam.ac.uk with a request to generate a key. The Email Details is a shortcut for this when the computer is networked.

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: Preconfigured users and passwords

Administrator – 2718

Manager – 1618

Operator – 3142

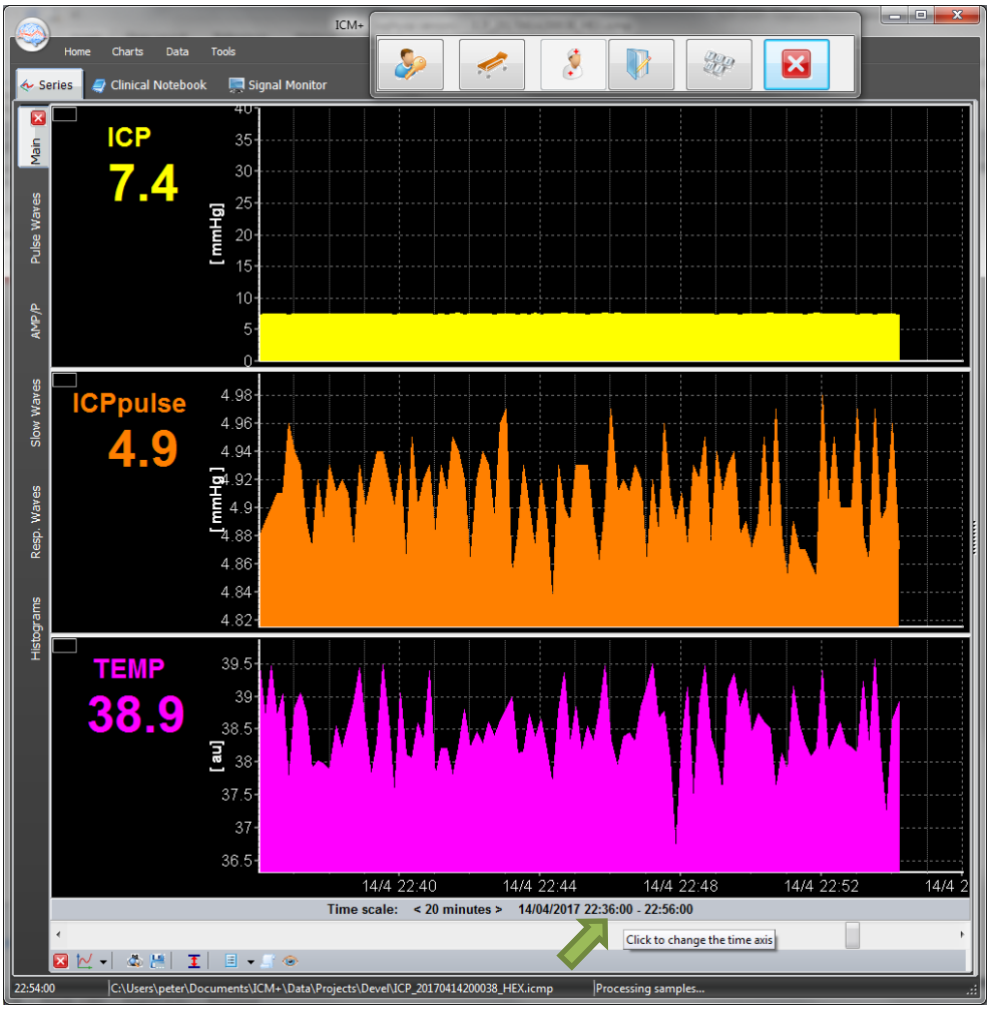
Nurse – 1414

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 6: Default configurations profiles

At the ICM+ installation time there are a set of configuration profiles provided. The profiles contain configuration of calculations performed on collected waveforms of ICP, and temperature (when fed via the patient monitor – no direct output of this modality from CereLink). All the parameters are calculated once every 10sec, or once every 60sec, depending on the profile. The display of these parameters is organised into several pages, which can navigated using a set of tabs organised vertically on the left side of the charts.



The pages above have been configured to show:

Tab	Content
Main page	Trends of the mean values of the measured parameters ICP and temperature, and the amplitude of the ICP pulse wave
Pulse wave	Shows parameters derived from the analysis of the ICP pulse wave
AMP/P	Shows the ICP mean pressure – amplitude relationship, which reflects the pressure/volume curve of the brain
Slow waves	Shows parameters derived from the analysis of the slow waves of ICP
Resp waves	Shows parameters derived from analysis of the respiratory component of ICP waves
Histograms	Presents mean ICP and the ICP pulse amplitude in the form of histograms summarising amount of time spent in critical regions (>20mmHg for ICP), as well as the dose of ICP (above the 20mmHg threshold) over the time period depicted (which can be changed by clicking on the time scale)

The following table contains explanation of all the parameters configured.

Parameter	Units	Description
ICP	mmHg	Intracranial pressure
AMP	mmHg	Amplitude of the fundamental harmonic of ICP pulse wave
HR	1/min	Heart (pulse) rate
RR	1/min	Respiratory rate
RAP		Brain compliance index
RA	mmHg	Amplitude of respiratory waves (fundamental harmonic)
ICPmax	mmHg	Maximum value of mean ICP over the calculation period
ICPmin	mmHg	Minimum value of mean ICP over the calculation period
Slow	mmHg	Equivalent amplitude of slow ICP waves (square root of power)
ICPsys	mmHg	Systolic ICP
ICPdia	mmHg	Diastolic ICP
ICPpulse	mmHg	ICP pulse amplitude
TEMP	Grad	Temperature

Appendix 7: Selected ICP monitoring references

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