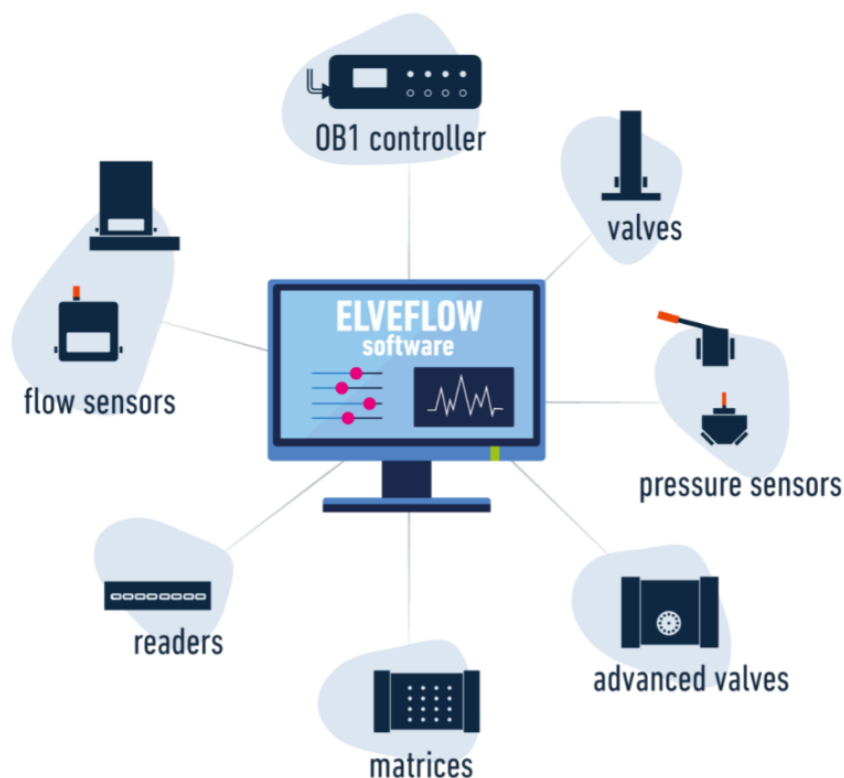


## Elveflow User Guide

# ESI ELVEFLOW SMART INTERFACE

DOCUMENT REF: UGESI 250429



## Symbols used in this document



**Important information.** Disregarding this information could increase the risk of damage to the equipment, or the risk of personal injuries.



**Helpful information.** This information will facilitate the use of the instrument and/or contribute to its optimal performance.



**Additional information** available on the internet or from your Elveflow representative.

## READ THIS MANUAL CAREFULLY BEFORE USING THE SOFTWARE



This manual must be read by every person who is or will be responsible for using the Elveflow Smart Interface (ESI).

Due to the continual development of the products, the content of this manual may not correspond to the new software. Therefore, we retain the right to make adjustments without prior notification.

### Important ESI safety notices:

1. The ESI gives the user complete control over Elveflow products. Beware of pressure limits for containers, chips and other parts of your setup. They might be damaged if the pressure applied is too high.
2. Use a computer with enough power for the ESI to avoid software freezing and setup damage.

If these conditions are not **RESPECTED**, the user is exposed to dangerous situations and the instrument can undergo permanent damage. Elvesys and its partners cannot be held responsible for any damage related to the misuse of the instruments.

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## Description

Elveflow Smart Interface (ESI) enables interactive control of all Elveflow instruments. Up to 16 Elveflow instruments can be controlled independently and simultaneously with a set of functions related to the instrument type, but which can also work together within microfluidic projects.

Thanks to an intuitive interface, this application allows microfluidicists to use Elveflow products from the simplest commands for beginners to complex manipulations for experts.

## Where to find the ESI

The Elveflow® Smart Interface's latest stable version can be [downloaded from the Elveflow website](#).

To alleviate bandwidth and access issues, two links for the same file are provided. The mirror link is the same file hosted on another server. So that you always have an accessible version to work with, 24/7.

You can also find SDKs for LabVIEW, MATLAB, Python and C in the same zip archive file.



**Do not install ESI directly from the Zip file**, and do not install directly from a USB key, this is likely to cause issues. Always copy the ESI.zip source to your computer, then unzip it before launching the installation process.

## Minimum system requirements

### ESI V3\_03\_00 or previous versions:

- Window XP SP3\* or later - both 32 and 64-bit versions are supported;
- USB 2.0 port or faster;
- 1 GB RAM;
- 3.0 GHz Pentium 4;
- 1 GB of free hard disk space.

\* Elveflow instruments hold integrated components that require specific libraries which are incompatible with Windows XP SP2 and older, Mac OS and Linux.

### ESI V3\_04\_00 or later versions:

- Window 7 SP1 or later;
- USB 2.0 port or faster;
- 1 GB RAM;
- 3.0 GHz Pentium 4;
- 1 GB of free hard disk space.

## Installation

1. Copy the zip file to your desktop, and unzip the downloaded file.
2. Open the Elveflow folder.
3. Run setup.exe.
4. Follow the instructions set by the installation assistant.
5. **Restart your computer** when prompted to finish the installation process.

## Updating the ESI

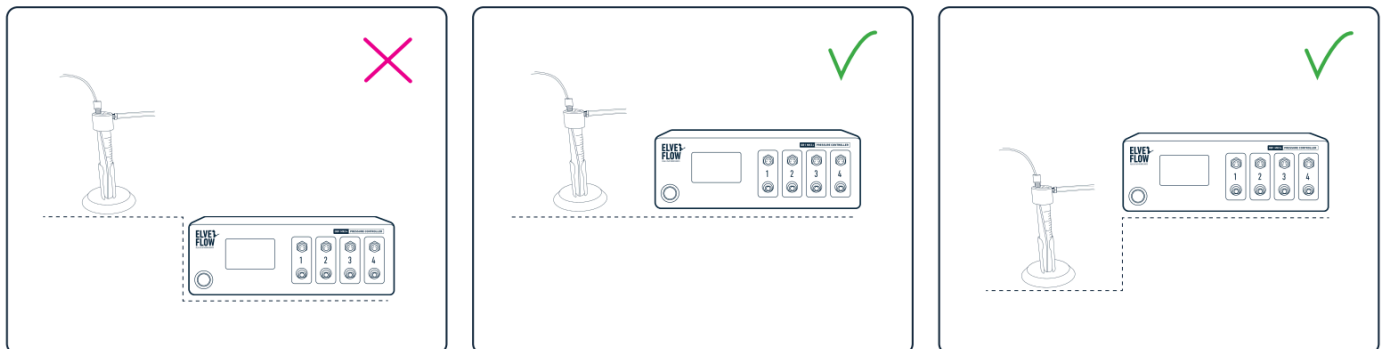
From the **ESI V3\_08\_00** version you will be notified, when the software starts, about any online update available. We strongly recommend updating instead of reinstalling as it will be much faster !

# Getting started

The following sections will guide you through the steps to add a new instrument or sensor, explore its basic and advanced features and use it with other instruments to automate your experiment.

## Before starting

Hydrostatic pressure can cause flow without any pressure applied. Therefore, to prevent backflow in a pressure regulator, always place liquid reservoirs below the instrument (OB1)



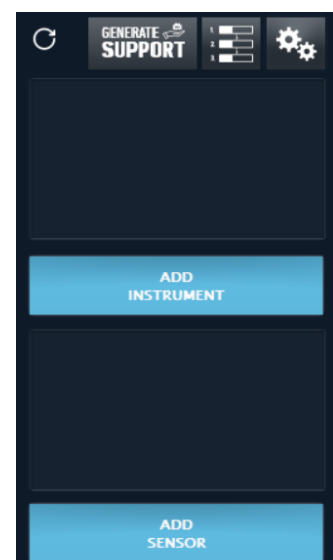
The Elveflow® Smart Interface's and the SDK main features and options are covered by specific guides, available through the [Elveflow Knowledge Base](https://support.elveflow.com/support/home). Please refer to those guides for a detailed description.

## Launch the Elveflow Smart Interface

Nothing simpler than double-clicking on the ESI icon that was added to your desktop during software installation! You can also find a shortcut to the software on "Start menu > Programs > Elveflow > Elveflow Smart Interface".



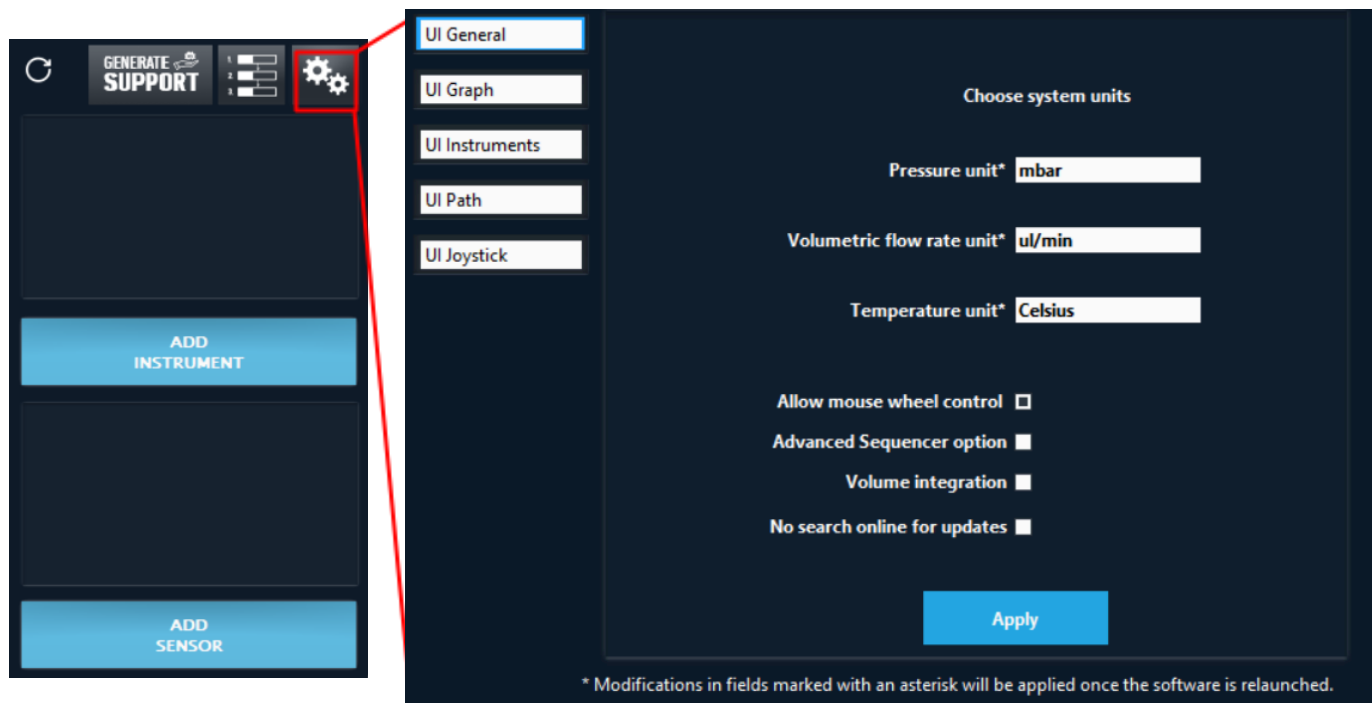
Once the software is launched you will see the start menu window, similar to this one:





## General settings

ESI v3 lets you choose the units to be used for displaying and controlling pressure, flow rate and temperature. In order to select the units you prefer, click on the General settings button:



In the general settings window, select your preferences and apply the modifications by clicking [Apply](#).

Two more settings are available:

[Allow mouse wheel control](#) allows you to modify the regulation value with your mouse wheel (used for OB1).

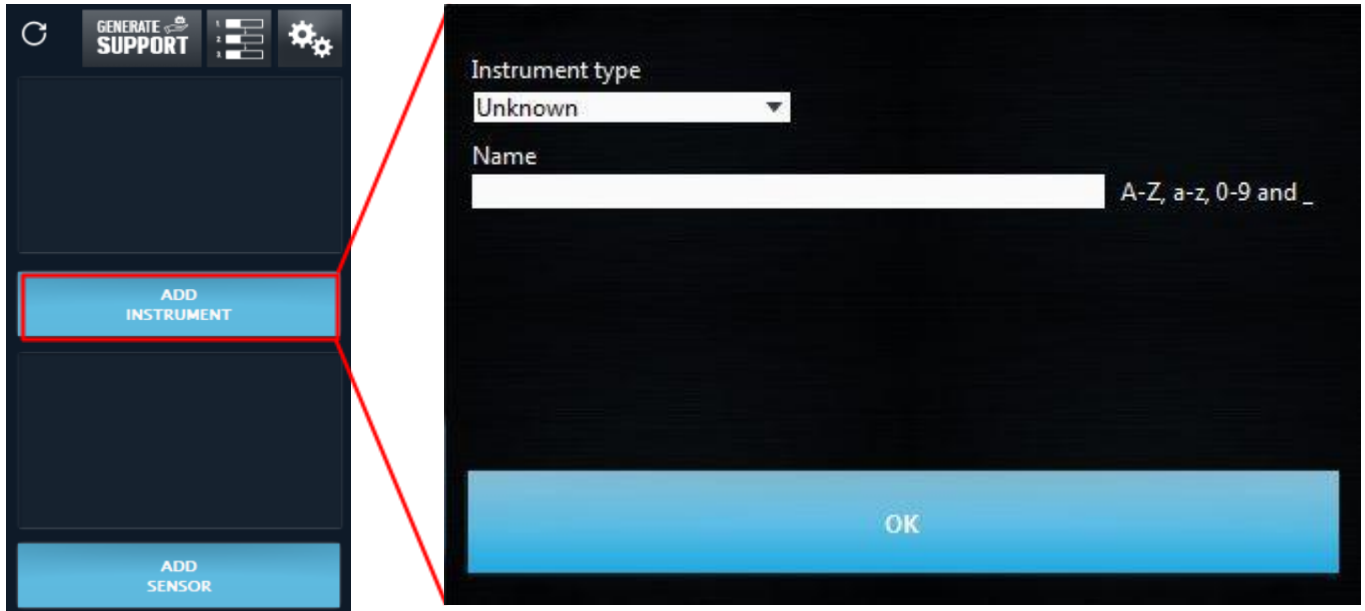
[Advanced Sequencer option](#) enables advanced options in the sequencer (See [Sequence](#)).

[Volume integration](#) shows an indicator with your OB1, when using a flow sensor, under the flow rate. You can reinitialize volume value by typing any value to this indicator.

In the [UI Graph](#) tab, the default graph settings such as Time format and default acquisition frequency can be edited (see [Graphs](#) section). The [UI Instruments](#) tab enables you to set general instruments properties as the acquisition rate. The [UI Path](#) tab enables you to select a default path for data recorded from a graph (see [Graphs](#)), the instrument configuration (see section [Using Configurations](#)) and the saved sequences (see [Sequence](#)). [UI Joystick](#) tab allows you to use the joystick provided by Elveflow and to choose the behavior of the Y axis to control the pressure of an OB1. Two options are available: either use the increment (see [Types of windows available \(OB1, MSR, BFS\)](#)) or continuous modification proportional to the joystick value.

## Add a new instrument

In order to add an instrument which is not already recognized by the software, click on the **ADD INSTRUMENT** button.



In the New Instrument window, select the **Instrument type** and give it a **Name**. Allowed characters are letters from A to Z (both upper and lower cases), numbers from 0 to 9 and underscores. The instrument name cannot contain any space.

Note that if more than one new instrument of the same type is connected to the computer, an instrument selector will appear at the top right corner. In order to be sure you are selecting the correct instrument, you can temporarily disconnect one of them from the computer while adding the other.

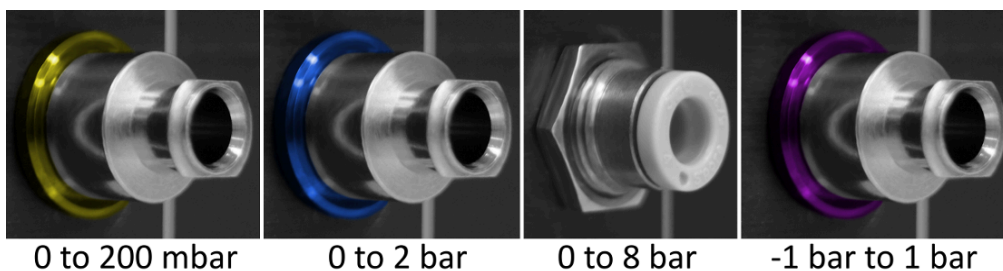
On the image above, in the empty space between **Name** and **OK**, more required settings corresponding to specific instruments may appear, as follows:

### OB1

Select the **Pressure range** for each channel: for example 200 mbar, 2 bar, 8 bar or -1 to 1 bar.



If you are not sure of the pressure ranges you have in an OB1, check the ring on its outlet(s).



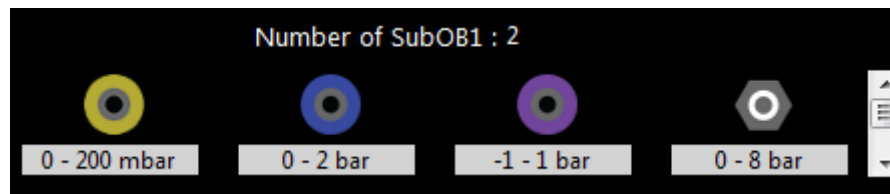
## OB1

Select the type of OB1 (MK3, MK3+ or MK4)

## OB1 Custom

Select the Name of the OB1 Custom.

The **number of subOB1** is indicated, and all the regulator types are automatically shown.



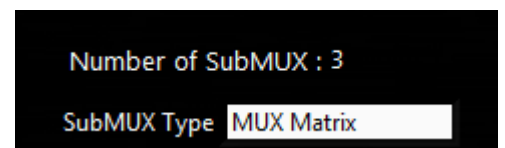
## MUX Distribution/Distributor/Recirculation/Injection, and MUX Flow Switch Matrix

Select the **Number of valves** (6 or 10 for MUX Distributor and 4, 8, 12 or 16 for MUX Flow Switch Matrix). Using Distribution/Distributor/Recirculation/Injection requires the installation of additional drivers to communicate with ESI.



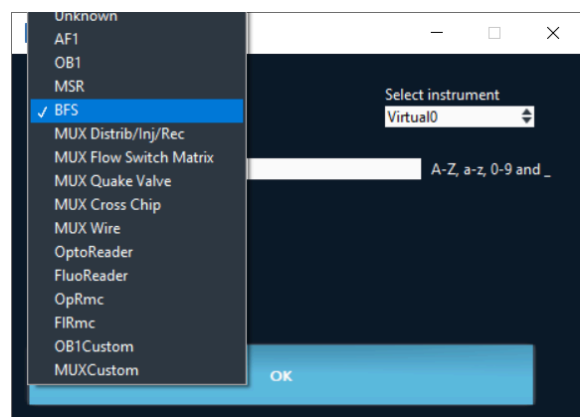
## MUX Custom

The **number of subMUX** is indicated. The type of the **subMUX** can be selected.



## BFS sensor

Due to its internal electronics, the BFS Coriolis sensor has to be added as an instrument. It also requires the installation of additional drivers to communicate with ESI

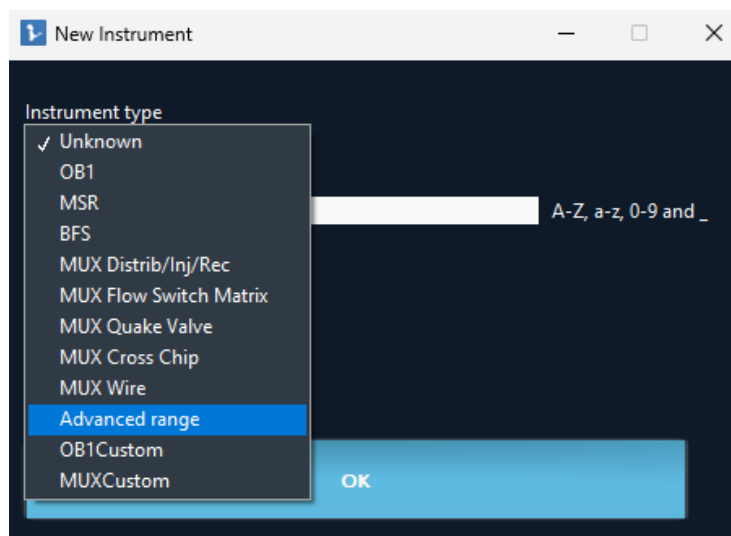




- BFS sensors have to be added as instruments in ESI
- If MUX Distribution/Distributor/Recirculation/Injection or BFS are used, additional drivers are required (<http://www.ftdichip.com/Drivers/D2XX.htm>). You can find these drivers in the same folder the ESI is installed. Default location would be C:\Program Files (x86)\Elvesys\driver (look for driver\_MUX\_distAndBFS.exe).

## ADVANCED Instruments

To use the ADVANCED instrument range, you will need to add them first by selecting "ADVANCED range" as the instrument type, assigning a name to the instrument, and clicking the "OK" button. The Elveflow Smart Interface (ESI) will then open the [ADVANCED Elveflow Software Module](#). For more information, please refer to the [User Guide of the Elveflow ADVANCED Software Module](#).



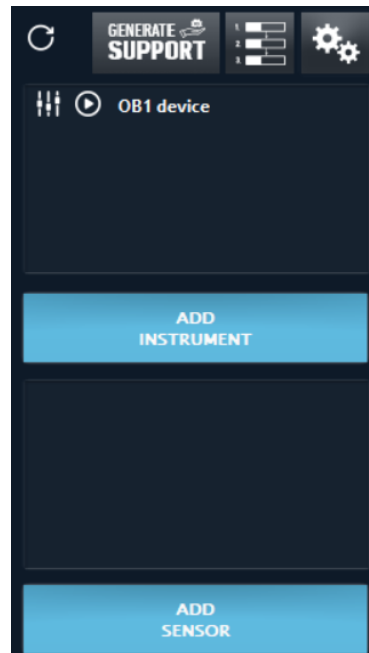
### Mandatory ADVANCED CONTROL CENTER connection

The **ADVANCED CONTROL CENTER** is the first module that must be connected to launch the [ADVANCED Elveflow Software Module](#). Failure to establish this connection will prevent the software module from launching. Ensure that the **ADVANCED CONTROL CENTER** is properly connected before attempting to use the [ADVANCED Elveflow Software Module](#).

## Other instruments

No additional configuration is required.

Click **OK** and your new instrument will appear in the main window.



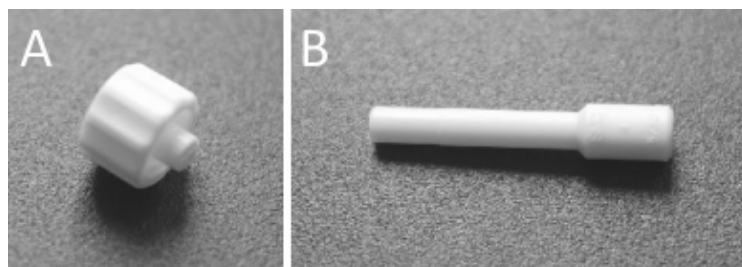
## Calibrate your instrument

Pressure regulator (OB1) requires calibration:

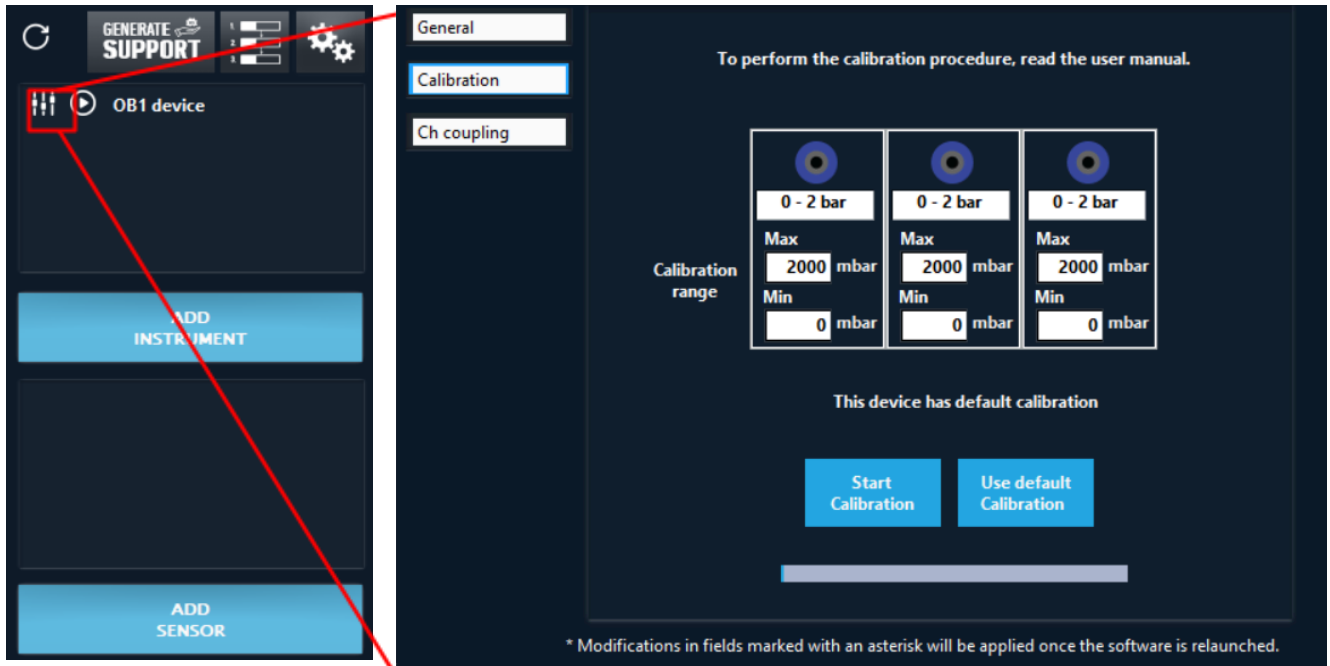
- When the instrument is connected to a computer for the first time;
- Any time a difference between the requested value and the measured value is observed.

Prior to calibration, close all pressure outlets with the appropriate Luer Lock or Push-in fittings:

- A: for 200 mbar, 2 bar and -1 bar outlets;
- B: for OB1 MK3 8 bar outlets, and all OB1 MK4 channels



Then open the **Instrument settings** windows and go to the **calibration** tab. The second line indicates which is the actual calibration in use (either default calibration or previously made calibration). Once all the pressure outlets have been closed, press Start Calibration. This process takes a few minutes. A detailed description of all available settings will be described in another section of this user guide ([Instrument tabs](#)).



- Have you chosen a wrong pressure range on an OB1, a wrong MUX type or number of valves? Go to the instrument's settings and in the General tab click on [Delete](#). You can now re-add it as a new instrument.
- If an instrument is already recognized by the ESI (you added it according to the previous steps) and you cannot see it in the instrument list, click on the [Refresh list button](#) to make it appear. This is useful when connecting an instrument to the computer after launching the ESI.



## Add a new sensor

Click on the [ADD SENSOR](#) button to open the following window:

The image shows the Elveflow Smart Interface (ESI) with the 'ADD SENSOR' button highlighted in red. A red line connects this button to a detailed view of the 'ADD SENSOR' dialog box. The dialog box contains the following fields:

- Sensor type:** Flow sensor (dropdown menu)
- Communication type:** Analog (dropdown menu)
- Sensor model:** 1.5 µl/min (dropdown menu)
- Name:** (empty text field)
- Connected to:** No Instrument available (dropdown menu)
- Channel:** 1 (dropdown menu)
- OK:** (button)

Select the [Sensor type](#) (flow sensor, pressure sensor, level sensor or custom sensor)

Select the [Communication type](#) (for flow sensor only)

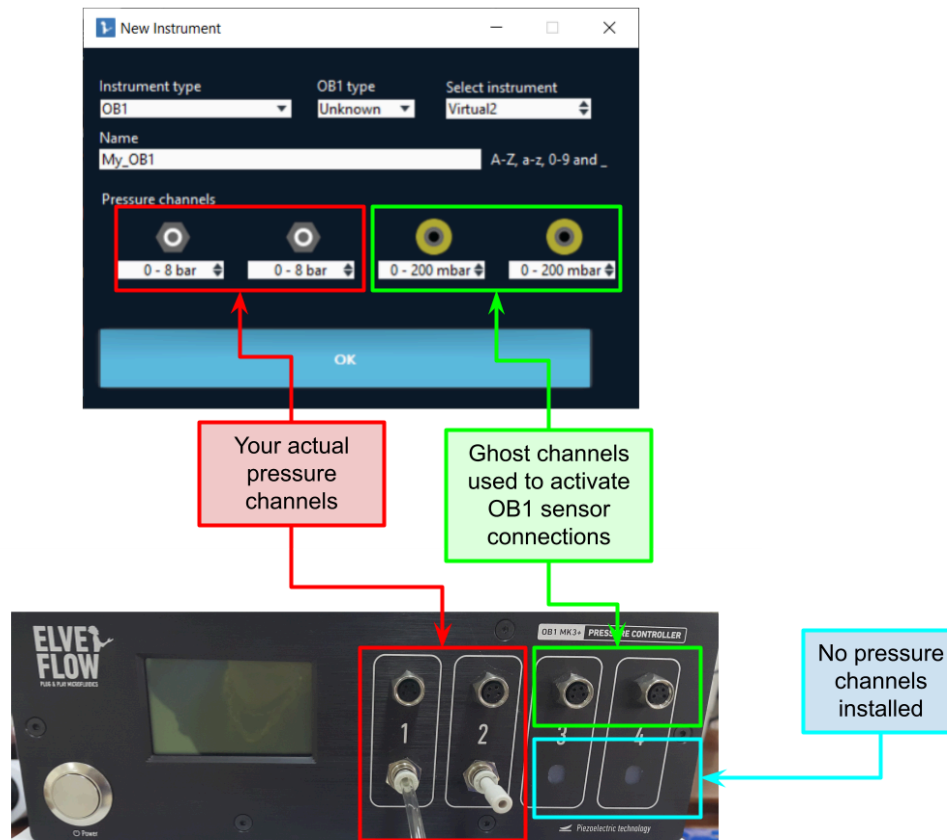
Select the [Sensor model](#). As soon as you select the type, the model list is updated so you will have the corresponding ranges available. For digital sensors, the sensor model is automatically recognized.

Give your sensor a [Name](#). Giving it a name will make it easier to configure the correct sensor later on. Select also the instrument that hosts the sensor ([Connected to](#)) and the selected [Channel](#).

## Adding sensors when there are no OB1 pressure channels installed.

The OB1 can host up to 4 pressure channels. This means that OB1 configurations with less than 4 pressure channels can often be seen. Let's take the example of an OB1 with only 2 x 8 bar channels installed, the 2 remaining slots are empty. The sensor electronic connections on the OB1 front panel can be activated in ESI just by installing ghost channels in the ESI, e.g. declaring the OB1 in the previous example not just as a 2 x 8 bar, but as say 2 x 8 bar and 2 x 200 mbar.

The user won't be able to use the ghost pressure channels, but doing so will activate the electronics of the channels, enabling the user to use pressure on the first 2 channels, and connect and read sensors on the 4 channels.



Adding sensors when there are no OB1 pressure channels installed requires that the sensor connections are installed nevertheless on the OB1, and internally connected to the OB1 electronics.

This operation is performed on demand by Elveflow personnel, when the OB1 is made in the workshop, but can be done also as a second step on existing OB1 instruments.

Please send an email to [customer@elveflow.com](mailto:customer@elveflow.com) to know more about this.



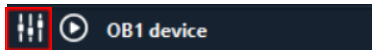
# Description of the interface

## Main Window Description

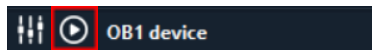
### Instruments

Instruments can be found in the top part of the main window:  
From left to right you can see:

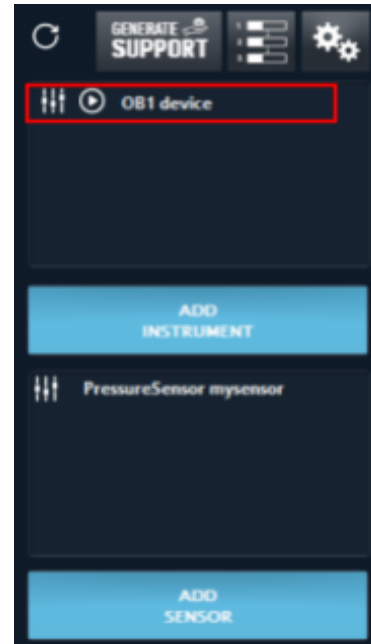
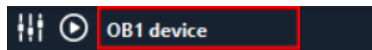
The [Instrument settings](#) button.



The [Launch control window](#) button.



And a text showing the [Instrument type](#) followed by the [Name](#) you have given to your instrument.

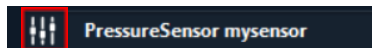


### Sensors

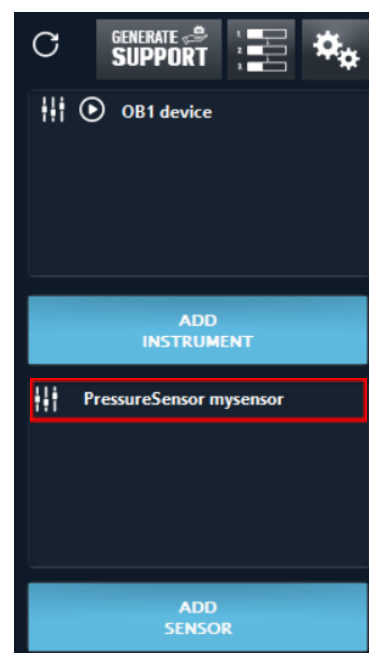
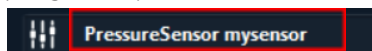
Sensors can be found in the bottom part of the main window.

From left to right you can see:

The [Sensor settings](#) button.



And a text showing the [Sensor type](#) followed by the [Name](#) you gave to your sensor.



## Control Window Description

In this section, the main control windows for every instrument will be described.

To open the instrument windows, click on the [Launch control window](#) button.

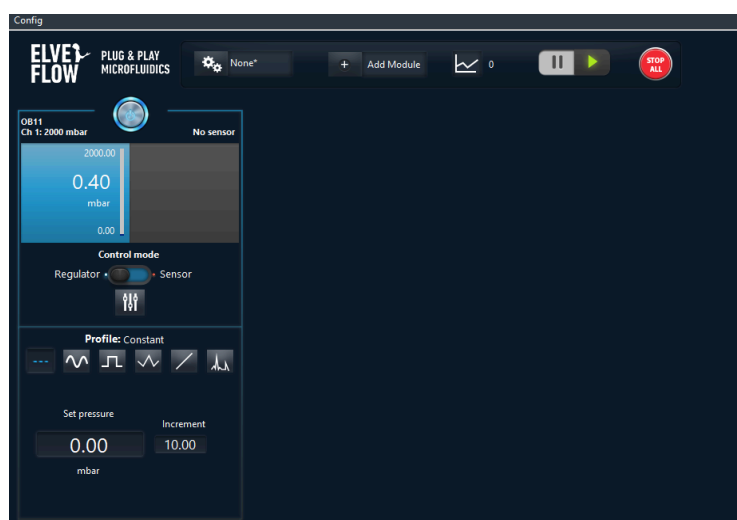


A new window will be open that enables instrument data visualisation and/or Instrument control

### Types of windows available (OB1, MSR, BFS)

Two types of windows can be found, one for instruments with regulator and sensor (OB1), and one for instruments with Sensor only (MSR, BFS).

OB1 control window

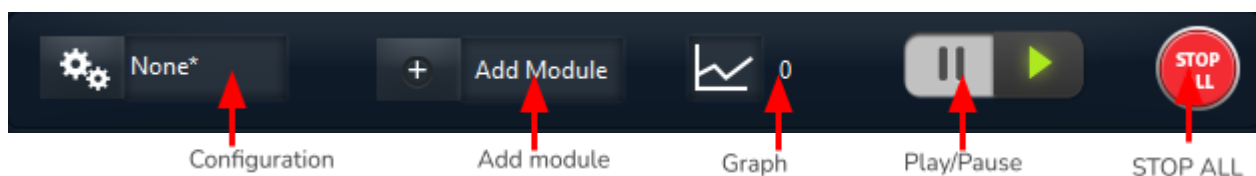


BFS and MSR control window



NB: In the examples above only one channel is present. For multiple-channels OB1 or a Sensor Reader, the content delimited by the white box with shaded edges will appear up to four times, corresponding to the number of channels available.

The left-hand and top side of this window present functions which apply to all channels at once:



The general [STOP ALL](#) button will toggle all the channels, i.e. will simultaneously bring all pressures down to zero (OFF).

The [Graph](#) button will open a live graph showing measured data of all regulators and sensors present in the control window. More details are presented at the end of this section.

The [Configuration](#) selector is an automation feature further described in a dedicated section ([Using configurations](#)).

The [Play/Pause](#) button allows you to edit settings without modifying the actual state of the instrument. It can be used to create and edit configurations.

The [add module](#) button allows you to add an extra module. Those modules are described in the [Modules section](#).

The white box with shaded borders contains the channel-specific controls and displays:



The [frame](#) around the controls indicates that this is the active channel.

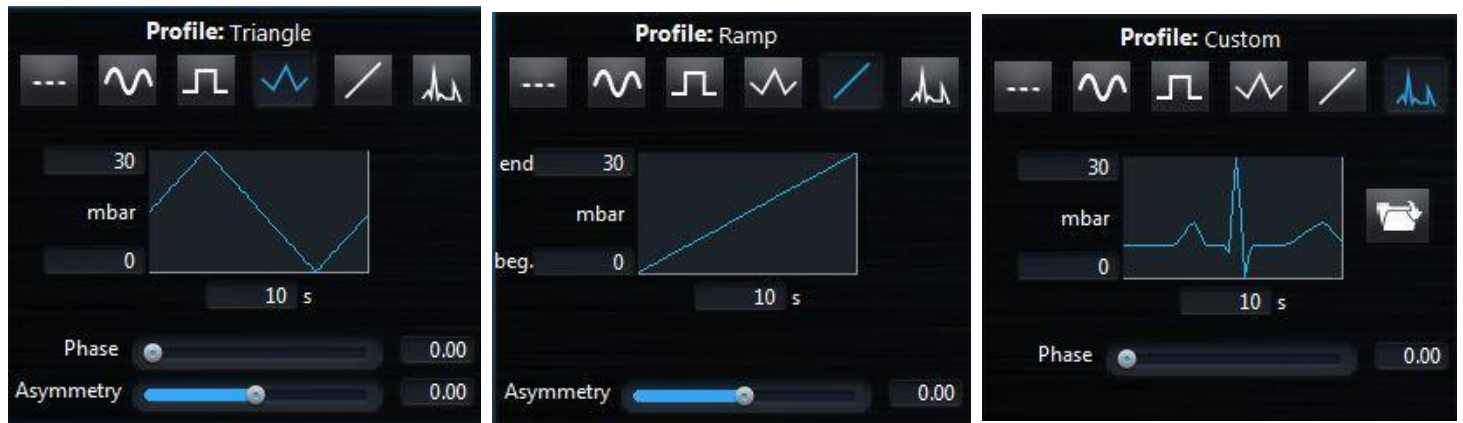
The [ON/OFF](#) button activates/stops the channel.

On the upper part, the left side is dedicated to displaying information about the regulator, while the right side displays the sensor information. The texts on each side indicate useful information about each part to help you quickly see which channel you are controlling.

The [actual value](#) of pressure, flow rate or voltage is shown in larger numbers with its unit below. Above and below are the [security limits](#), which can be edited in the configuration menu.

## Set up a profile

Different [Profiles](#) are built-in to make the setting-up of an experiment quick and easy:



**Constant** means that the value shown in [Set pressure](#) is applied continuously. The [Increment](#) value will be added (removed) to the [Set Pressure](#) when the keyboard key “arrow-up” (“arrow-down”) is pressed. If the mouse wheel control is activated the mouse wheel will have the same effect.

**Ramp**, **Sinus**, **Square** and **Triangle** are functions that execute the shape depicted in the schematic. The range and the duration of the chosen pattern are shown respectively on the left and at the bottom of the graph. Those 3 indicators can be directly edited here. **Phase** and **Asymmetry**, when available, can respectively help positioning the curve in time and shaping it. For **Ramp** profile the starting and ending pressure should be set.

**Custom** profiles can also be imported from CSV or TXT. The imported files shall contain two columns separated by a comma (CSV, exported from an excel spreadsheet) or by a tab (TXT). The first column indicates the time; the second indicates the pressure, flow rate or voltage. Click on the [Load data](#) button to indicate a file to be loaded, then, indicate the min and max values in the profile fields on the left of t

## Channel configuration

The channel configuration windows can be open by the conf

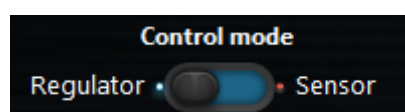


A very useful feature for chip integrity control or a means to quickly obtain on-demand ramp profiles is [Max pressure slope](#), which is accessible through the Channel settings button below. It ensures that the pressure change rate will never go above this value.

By adjusting the maximum ramp, which corresponds to the maximum pressure variation a channel can perform over a certain time, any modification in pressure will occur at the chosen rate, unless the selected profile imposes a lower rate.

## Feedback loop (Sensor mode)

As obvious as it sounds, a sensor only reads a value. Sometimes, the user would like to work at a controlled flow rate for instance. You can set a flow rate, pressure or voltage on a sensor and have the ESI automatically adjusting the pressure applied in a regulator. In [Control mode](#), select [Sensor](#) to active this feature.





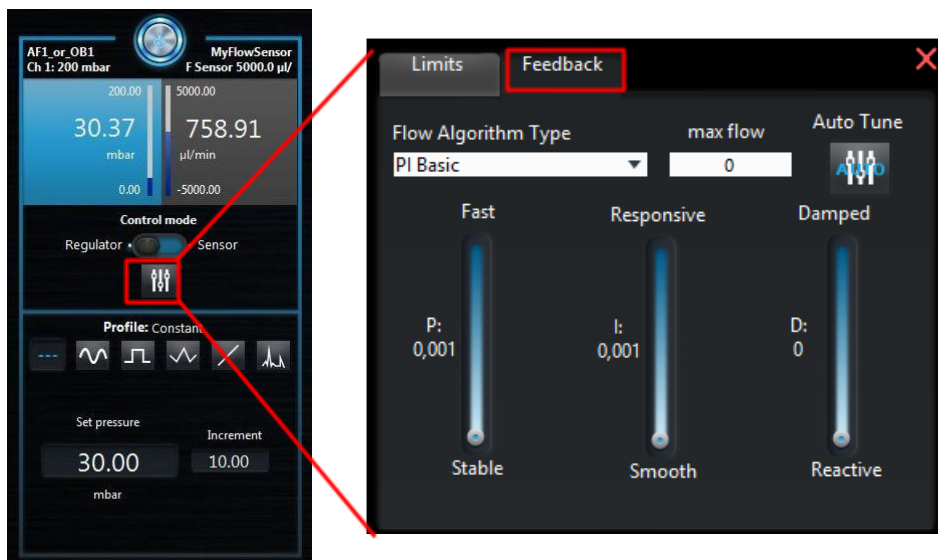
In order to pair a pressure regulator with a sensor connected to MSR or BFS, the [virtual channel](#) may be used (see [Modify instrument/sensor settings : OB1](#))

The sensor mode can be used with constant set values, all built-in profiles or a custom profile loaded by the user. The ESI uses a PID-like algorithm to adapt the pressure as a function of the value set to the sensor. In most cases, values for [Proportional](#) (Fast/stable) and [Integral](#) (Responsive/smooth) terms between 0.05 and 1.5 (Default value: 0.001) are well adapted to allow a good regulation. Nonetheless, each system has an optimal operating point that needs to be tuned depending on the setup and the desired response. It is therefore possible that values beyond this proposed value range offer a better regulation for a particular system. If the user identifies the need to change these parameters, they both can be found in the [Channel settings](#) menu (see section Channel configuration p). Several PID have been developed and can be selected from [PID Type](#):

PI Basic: Generic PI regulator can be used for most applications.

PID Basic: Generic PID regulator that includes the D parameter and that can be used for most applications.

Large Reservoir: PI regulator more adapted for large volume (lot of air), since it takes time to fulfill the reservoir.



The PID optimum parameters can be

obtained using the [Auto Tune](#) functionality.

The [max flow](#) parameter can help to have optimum regulation around P and I value close to 1 when the working range is much smaller than the sensor range.



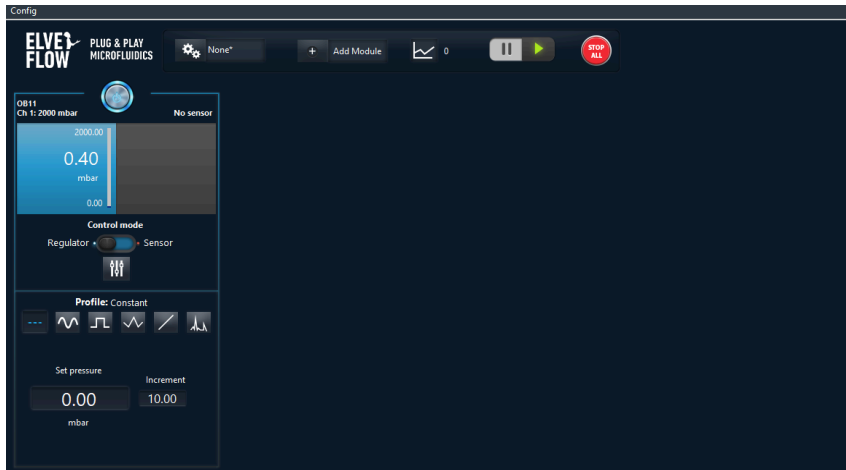
Using the [Auto-Tune](#) feature without proper conditioning of the fluidic setup will result in poorly chosen PID parameters. Elveflow provides PID auto-tuning to get users to the optimal PID values with a reasonable amount of effort. Once the Auto-Tune feature has been run, a small amount of manual adjustment with the understanding of their effects can provide the control you need for your application.

## Graphs

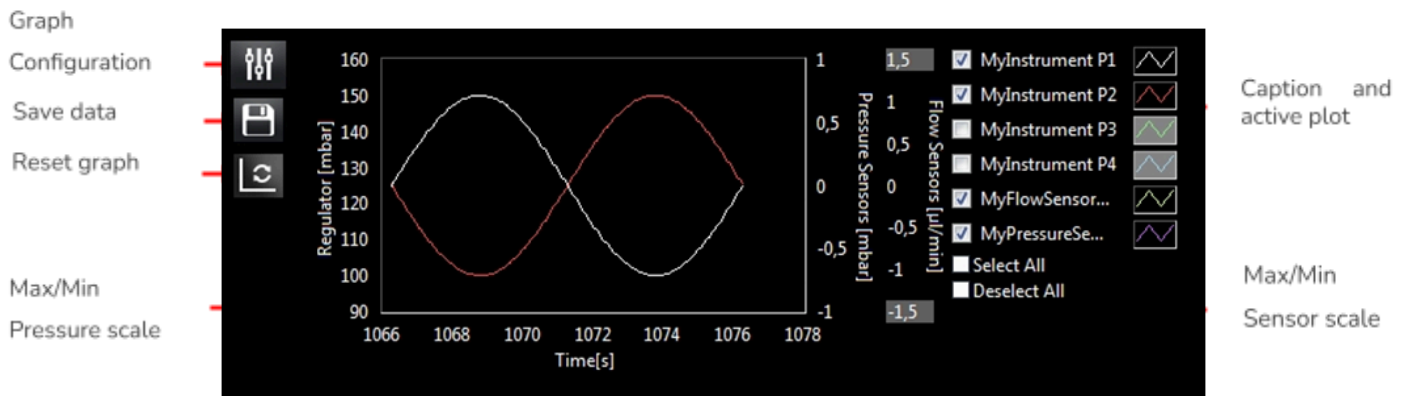
Up to 10 independent graphs can be opened for each OB1, Sensor Reader or BFS control window. The advantage of having so many graphs available is that, for each channel, the user can perform a fine adjustment of the display range without having several superimposed curves in the same window. If needed, all curves can be shown in a single graph.

Click on the [Graph](#) button on the control window to open a graph window.





The graph window's size can be adjusted or can be easily maximized for better viewing. As soon as the window is launched, the graph starts to auto-update with live data from all regulators and sensors connected to the corresponding instrument.



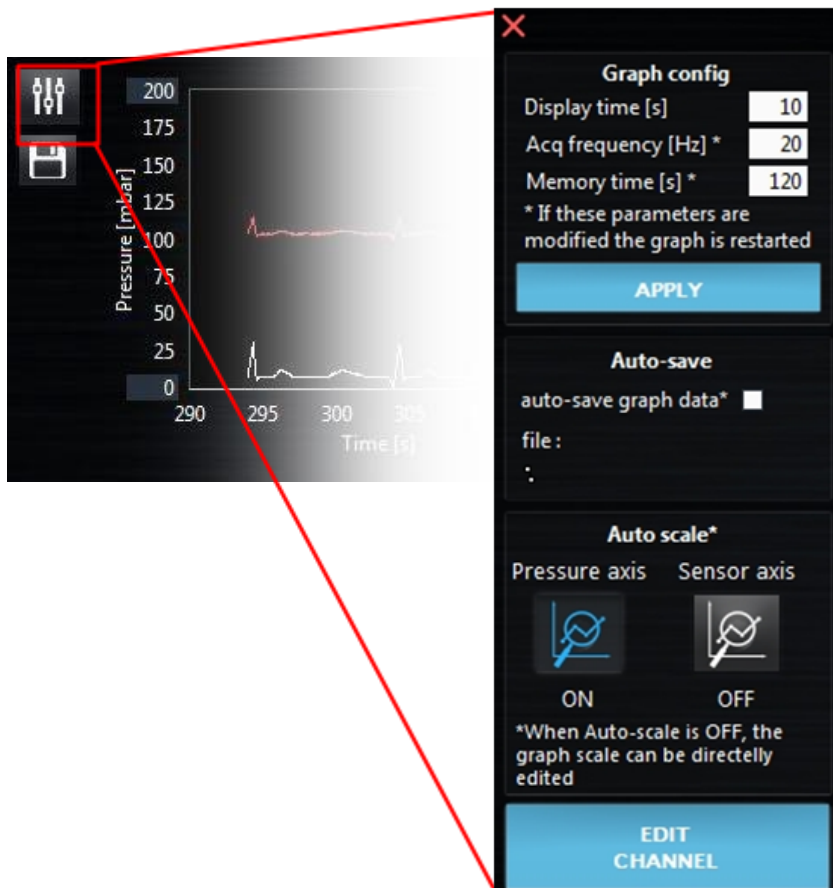
To adjust the ranges of the vertical axes of the graph, edit the maximum and minimum value of the range (gray editable zone). If the auto-scale is active (as for the regulator axis below), the range cannot be edited (see Graph settings below).

The graph to be visualized can be selected using [Active channel](#).

To restart the graph, click on the [Restart graph](#) button. Click the [Save data](#) button to export data from the graph. Notice that the data exported will contain the latest measured values during the period indicated in [Memory time](#), not only the data displayed in the graph. Moreover, all data from the elements displayed at the right-hand side of the window (even if not ticked) are exported at once. The target pressure of every regulator is also saved.

The click on the graph configuration button to open graph settings windows:





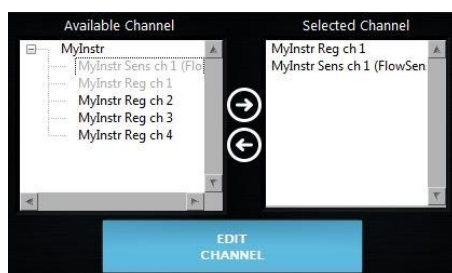
Inside the **Graph settings** the user can modify how much data is displayed by adjusting the **Display time** and setting the data **Acquisition frequency**. Note that this simply represents how often data is sent to the graph. Real data acquisition from the instrument occurs at a fixed, high frequency. To modify the default graph settings, see [General settings](#).

If needed, data can also be kept in memory for a longer time than the limit displayed in the graph. Using a **Memory time** higher than the **Display time** ensures that sufficient data can be later exported while keeping the view in the graph reduced and practical during an experiment.

For experiments that last many hours, or if the user needs to be sure that data is kept safe at all times, the **Auto-save graph data** option can be activated. In this case there will be no need for exporting data; they will be saved every 1 minute in the selected file.

The axis **auto-scale** of both axis (pressure axis and sensor axis) can also be enable/disable from this window.

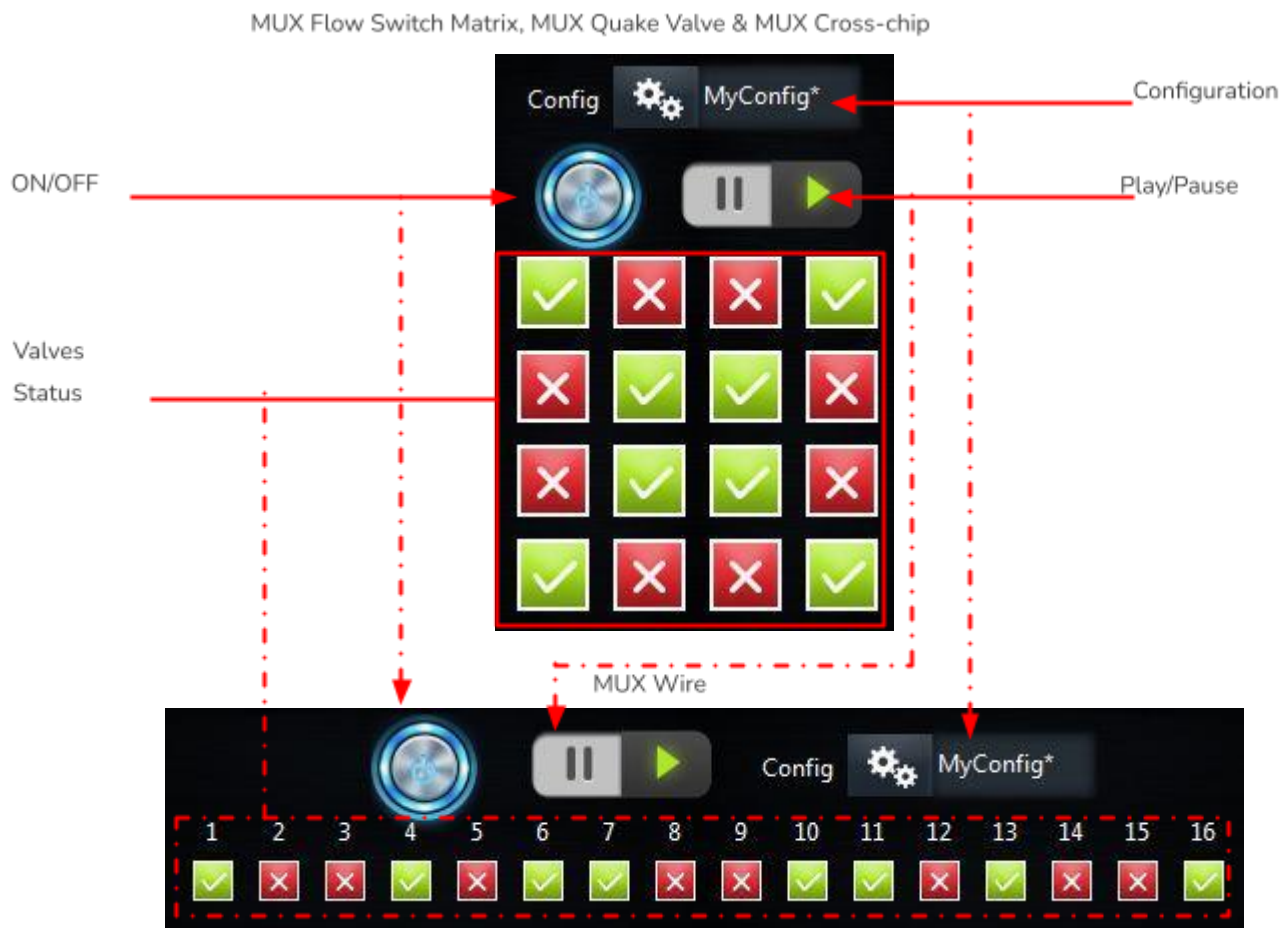
The **Edit Channel** button enables the user to change the channel to be visualized. It opens the following windows:



A list of all **Available channels** is listed on the left panels. The selected channels are gray. The **Selected channels** are listed on the right panel. Double click on a channel or use the right/left arrow to select/deselect. If an instrument is double clicked, all the channels from that specific instrument are selected.

## MUX Flow Switch Matrix, MUX Wire, MUX Quake Valve and MUX Cross-Chip

The MUX is a valve matrix that can be used either to block/let flow a fluid (MUX Flow Switch Matrix, MUX Wire) or to distribute a fluid from an inlet to a selected outlet (MUX Quake Valve and Cross Chip). Below is represented a typical control window for a MUX.



MUX Flow Switch Matrices can have 4, 8, 12 or 16 valves, so up to three columns may be deactivated according to this setting.

Each **Valve** button in the 4x4 matrix corresponds to a valve in the MUX. Green shows that the valve is opened, while red shows that it is closed. In MUX Quake Valves, green means that the outlet is connected to the Common open inlet and red to Common close.

For MUX Wire, a 1D array of buttons represents the power state of each output. It can have 8 or 16 valves.

Note that those control windows also display an **ON/OFF** button. If the button is ON, the valve states are those represented in the 4x4 matrix or 1D array. If it is OFF, all valves are closed (MUX Wire, MUX Flow Switch Matrix and MUX Cross-chip) or all outlets are connected to Common close (MUX Quake Valve).

The **Configuration** selector appearing at the top of the window is discussed in a dedicated section ([Using configurations](#)).

The **Play/Pause** button allows you to edit settings without modifying the actual state of the instrument. It can be used to create and edit configurations.



## MUX Distribution, Distributor, Recirculation or Injection (D-R-I)

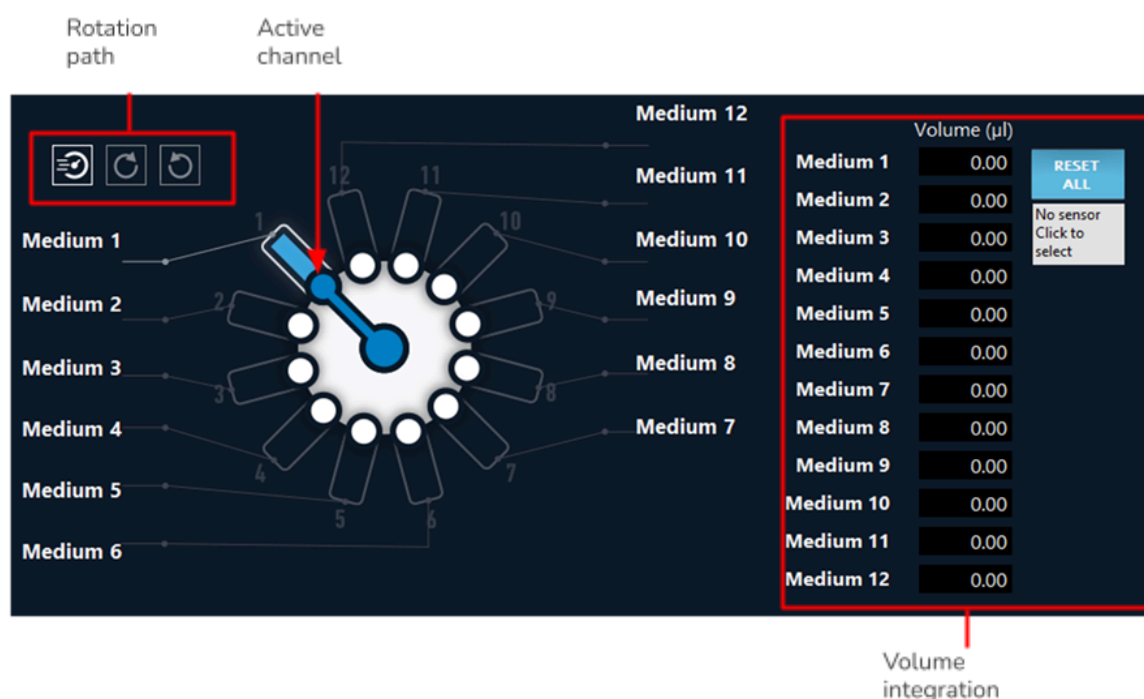
The MUX Distribution/Distributor is a rotary valve allowing a single inlet/outlet to be connected to up to 12 different reservoirs/chips for selective injection. Three models are available in ESI: 6 and 10 valves for MUX Distributor (deprecated) or 12 valves for MUX Distribution. The MUX Recirculation/Injection is also a rotary valve with 6-port/2-positions. The MUX Injection is deprecated and the new version is Recirculation but both MUX are available through ESI.

### MUX Distribution/Recirculation:

On the left side for MUX Distribution the [Rotation path](#) can be chosen between 3 rotation pathways, shortest, clockwise and counter-clockwise.

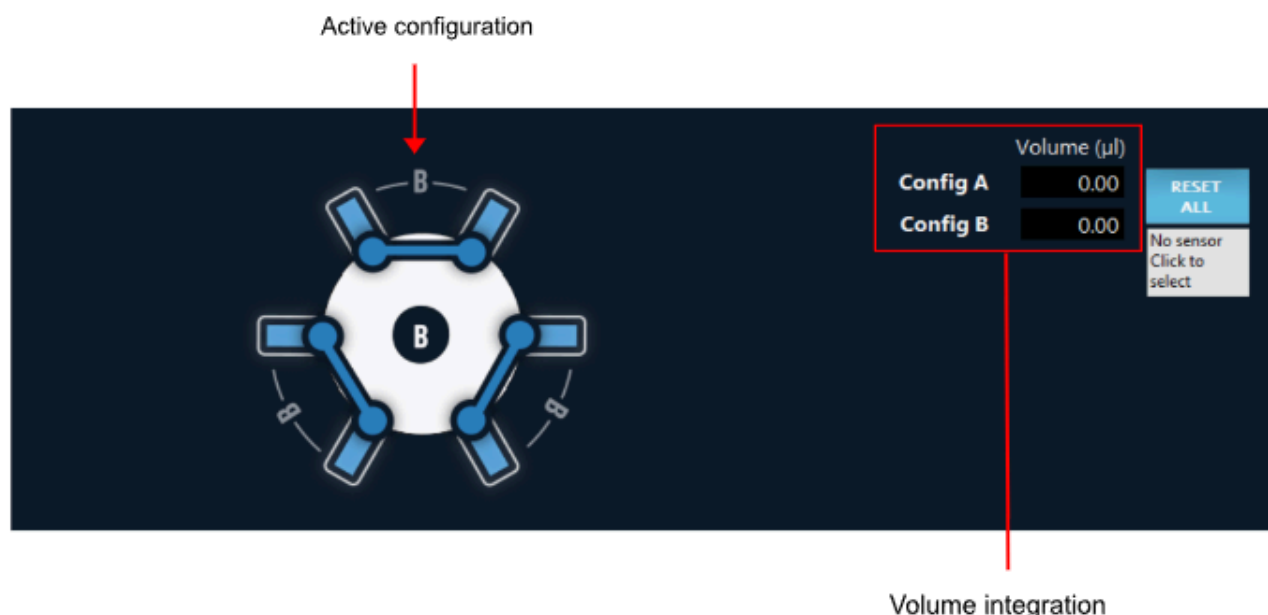
The [Wheel](#) both displays the current state and serves as a control for valve position. Click on any valve to select a new position.

The [Media names](#) can be modified by double-clicking on the text (both connected to the Wheel or on the list on the right-hand side) and typing a new name.



For the MUX Recirculation two [configurations](#) are available, respectively A and B.

Like for the MUX Distribution, the [Wheel](#) both displays the current state and serves as a control for valve position. Click anywhere on the wheel to change configuration.

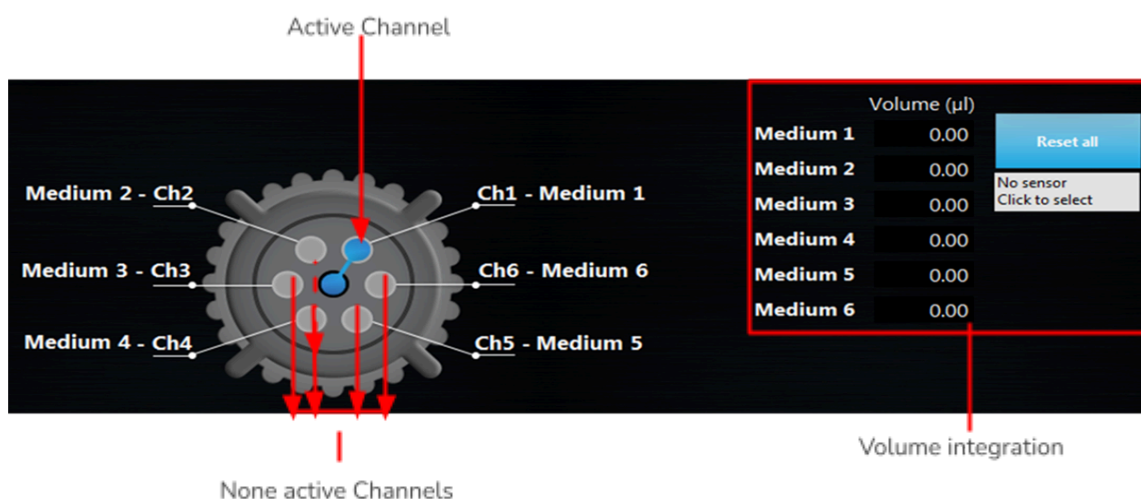


If a [flow sensor](#) is connected to the central line of the valve - and to another instrument such as an OB1 or a Sensor Reader, which can read its data – it can be integrated to the MUX Distributor or MUX Recirculation in order to calculate the volume flowing through each channel. The ESI will add the volume calculated by the sensor to the list, at the active valve position. Click on the gray box on the right to open a list of available sensors.

The [Reset all](#) button sets all volumes back to zero. If needed, each volume on the list can also be modified manually.

## MUX Distributor/Injection:

The controls and extra features are similar for both models. The image below represents a 6-valve MUX Distributor.



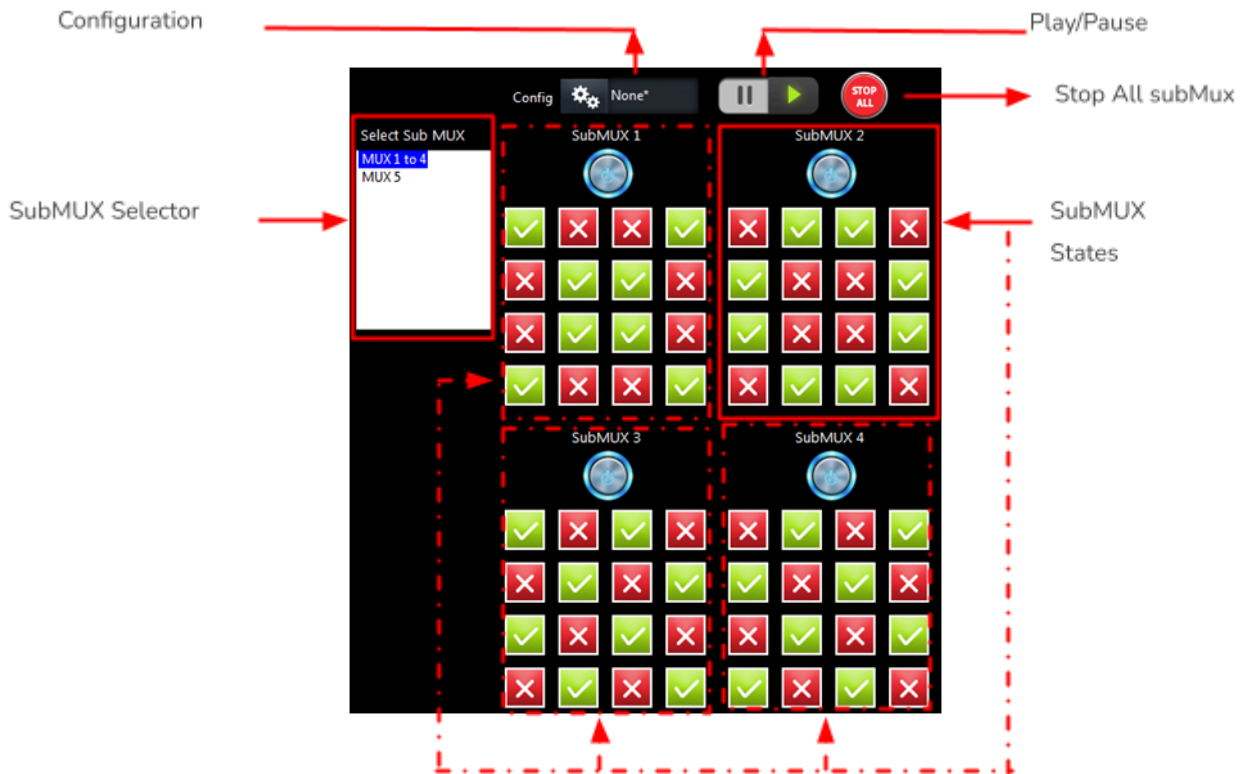
Similar features to the MUX Distribution/Recirculation are available except the Rotation path for MUX Distribution. Please refer to the previous paragraph for more details.

## Meta Instruments (OB1 Custom, MUX Custom)

Meta-instruments are instruments that use sub instruments and allow an easy visualization and handling of them as a single entity, in a single window. Those instruments provides all the functionalities than normal instruments.

## MUX Custom

The custom MUX enables the visualization of up to 4 MUX simultaneously. If more MUX are present, a [SubMUX Selector](#) appears on the left of the window to switch between MUXs. As for standard MUXs, this instrument can be edited with the [Play/Pause](#) button and can be controlled with [configurations](#). Those configurations save the state of all subMUX of this instrument (including the one not shown in the windows).



## OB1 Custom

The custom OB1 enables the visualization of several OB1s in a single window. All regulator pressure and sensor values can be read in the [regulator and sensor panel](#) (top). For fast modification of the instrument, the [feedback](#) values (green button) and the [constant value](#) of every channel can also quickly be modified by this panel. On the bottom left panel, the [SubOB1 Selector](#) allows to select the active OB1 controllable in the bottom right panel. As for standard OB1s, some instrument functions are applicable to all channels: the [Play/Pause](#) button enables to edit all the channels and change them all at the same time. All channels can be controlled with [configurations](#). Those configurations save the state of all subOB1 of this instrument (including the one not shown in the windows) and can be recalled by a single click. As for other OB1, modules can be launched from the [Add module](#) button. The [Graph](#) button will display a graph containing all the channels of this instrument. The [stop all](#) button switches all the channels to off. Finally, the stop gas button will close the gas inlet.

Regulator and sensor panel



SubOB1 selector

Channel Configuration

Instrument function

## Using configurations

Some instruments allow the use of [Configurations](#), as previously mentioned: OB1s, MUX Flow Switch Matrices, MUX Quake Valves, MUX Wire, all sensors(MFS,MPS...) and MUX Cross-chips MFS. This feature is very practical when the user needs to quickly alternate between two or more states of the system, e.g., from a sinusoidal profile between 0 and 100 mbar to a custom profile between 300 and 400 mbar.



At first the [Configuration](#) selector appearing in the control window will have only the None\* case. This means that no configuration is available. In order to create and use configurations:

- Set the desired parameters to controls (e.g. a pressure profile or valve state).
- Open the [Config](#) menu on the top of the control window.
- Save the configuration. The ESI will propose a standard location, but configurations can be saved anywhere in the computer.
- Repeat the three steps above for as many configurations as required.

In the end of this process there will be several configurations available on the selector. Changing from one to another will automatically change the state of the instrument.

Instruments [Configurations](#) are required to control instruments in a sequence (see [Sequence](#) section).



To create new configurations without modifying the actual state of the instrument, use the [Play/Pause](#) button.

Three more functions are available:

[Load](#) allows the user to use a configuration that has been previously saved.

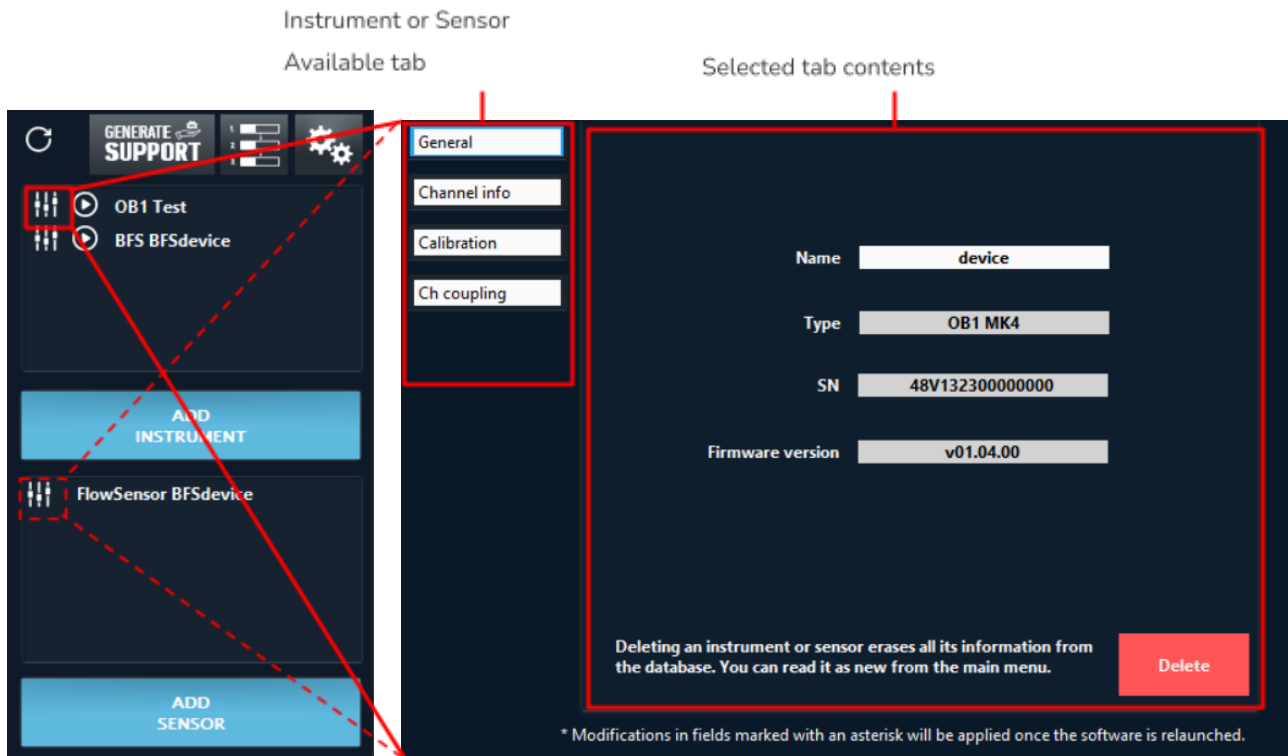
[Remove](#) will delete the actual configuration from the list.

[Open folder](#) gives access to the standard configuration folder, where the user can easily manage all the configurations already saved.

For the sensor you can find the [Configuration](#) selector into the instrument configuration. Sensor settings are written inside the configuration file, and can be loaded into a sequence step. The configuration file can be used for two sensors of the same model regardless of their serial number.

## Modify instrument/sensor settings

From the main window, as observed before, the user can have access to the instrument-specific settings window. Click on the [Instrument settings](#) or the [Sensor settings](#) button to access it.



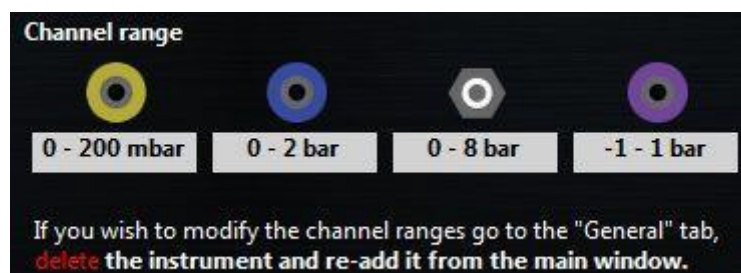
### General tab

The [General](#) tab is available to all instruments and sensors. It shows the [Name](#) and [Type](#) of the part and a [Delete](#) button which can be used to remove it from the instrument/sensor list, in the case a mistake has been made while adding it or if it will not be used anymore.

### Instrument tabs

#### OB1, OB1 Custom

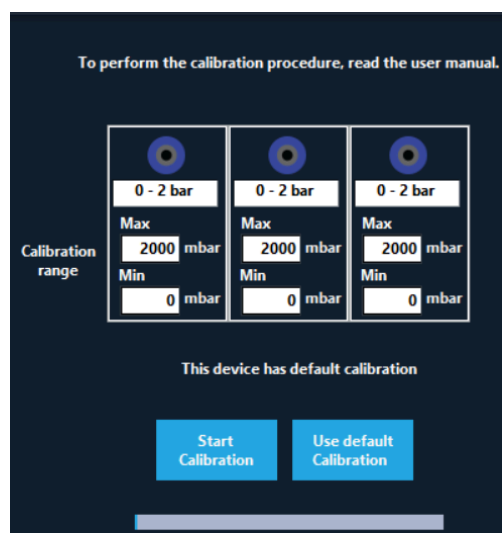
The [Channel info](#) tab displays all pressure channels present in the instrument and their [ranges](#). Available to: OB1 and OB1 Custom.



In the [Calibration](#) tab the user can [Start a calibration](#) and see its progress on the [Status bar](#) (remember to close all pressure outlets with the dedicated cap before calibrating). A [Default calibration](#) can also be used if needed. The used calibration is shown in the second line.

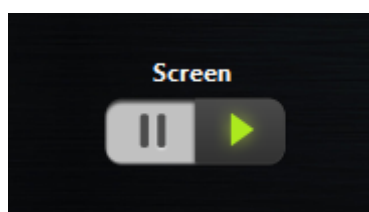
Calibration should be conducted on the entire pressure range, but custom settings can be used for special applications.

Available to: OB1.



OB1s have screens to show the actual pressure and sensors values. In the [Screen](#) tab, the user can activate or deactivate the screen update. For OB1 MK3, OB1 MK3+ and OB1 Custom devices, the Screen update takes about 50ms and therefore can cause some fluctuation on the pressure when profile pressure is required. For very sensitive experiments when the best performances are required, the screen should be switched off.

Available to: OB1 MK3, OB1 MK3+ and OB1 Custom.



[Channel coupling](#) can be useful when the set values in multiple channels have to be modified proportionally and simultaneously. [Select a channel](#) on the left side and couple it with any [available channels](#) on the right by a [multiplication factor](#). For instance, if channel A is coupled to channel B by a factor of 2, every pressure increase of 10 mbar in channel A yields a 20 mbar increase in channel B, and every pressure increase of 10 mbar in channel B yields a 5 mbar increase in channel A.

Available to: OB1.



Selected channel	Available virtual channels	Multiplication Factors (0=no coupling)
MyInstrument Virtual Ch. 1	MyOtherInstrument Virtual Ch. 1	0.8
Apply	MyOtherInstrument Virtual Ch. 2	52
	MyOtherInstrument Virtual Ch. 3	23
	MyOtherInstrument Virtual Ch. 4	2

## MSR (Sensor Reader)

The MSR [Acquisition Frequency](#) and hardware [filters](#) can be activated to pre-treat the single read by a Sensor Reader in the [Filter and Acq Freq](#) tab. The acquisition frequency can be set up to 1000 HZ.

Available for: Sensor Reader.

Ch. 1	Ch. 2	Ch. 3	Ch. 4

Acquisition Frequency (Hz)

## BFS (Mini Cori-Flow)

The [BFS Config](#) tab can be used to set BFS parameters.

The BFS [Filter](#) is an electronic filter within the instrument that can be tuned by the user.

Filter 0.48

Smooth  Fast

0.01 0.1 1

The value of this parameter can be selected between 0.01 (smooth, but slow response) and 1 (fast but noisy response). This parameter can have a high impact on PID regulation.

BFS is an instrument that outputs mass flow (in g/h). This instrument can also measure the fluid density with high accuracy. This capability is used to determine the volume flow.

Density measurement

Continuous ☒ Punctual

Density: 784.816

The fluid density can either be measured continuously or only one time. To update the density, switch back to continuous and then go back to punctual.

NB: Continuous density measurement increases by 20 ms the measurement cycle.

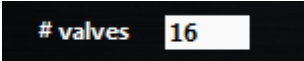


Flow unit can be set to mass flow instead of volume flow. Two options can be selected, either Volumetric flow (default settings that use density) or Mass flow (in g/h). This option is visible in the scaling tab of the BFS sensor parameters.

## MUX Flow Switch Matrix

The [number of valves](#) in a MUX can be changed, in the case a mistake has been made while adding the instrument or if your MUX has been upgraded.

Available for: MUX Flow Switch Matrix.



# valves 16

## MUX Distribution/Recirculation

In the MUX settings, a button to [Home Valve](#) is available. Home valves are sometimes needed in particular use of the MUX Distribution/Recirculation. You can perform this here.

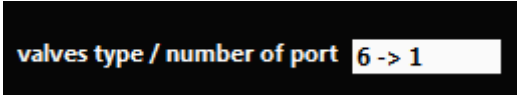


Home  
Valve

## MUX Distributor/Injection

The [valve types/number of port](#) of a MUX Distributor/Injection can be modified in the [Valves](#) tab. The different options are Injection, 6->1 or 10->1.


Available to: MUX Distributor/Injection.




valves type / number of port 6 -> 1

## SubMUX

The [number of subMUX](#) indicates the number of sub units contained in the MUX Custom. The [SubMUX Type](#) can also be edited in this window. Finally the subMUX can be reordered by clicking on the [Reorder subMUX](#) button.



Number of sub MUX 3

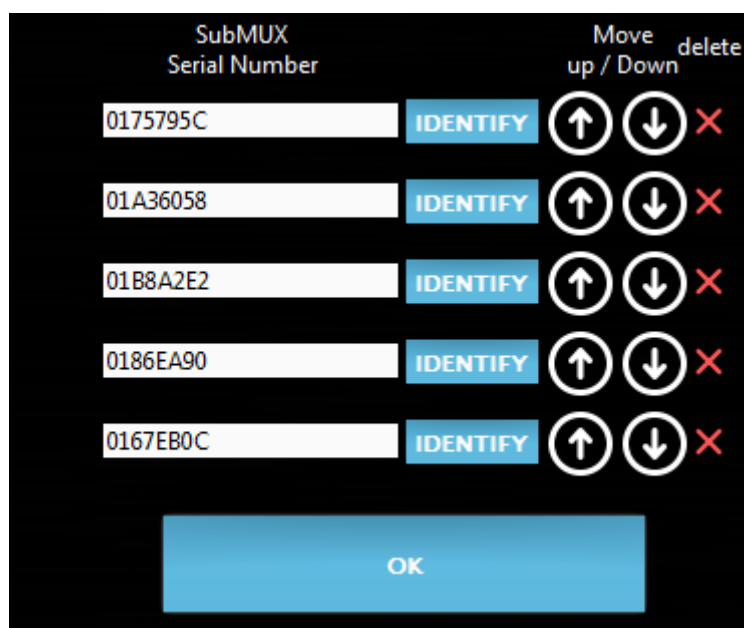


SubMUX Type MUX Matrix



Reorder  
SubMUX

When this button is clicked, a new window will open:

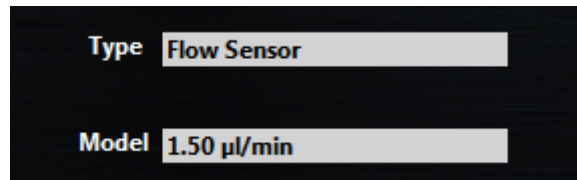


The first column indicates the MUX [serial number](#). The [identify](#) button will open and close all the valves of the selected subMUX while all the other MUX valves are closed. This enables recognition of this MUX. Use the [Up](#) and [Down](#) button to reorder. The red cross is used to delete one specific subMUX for the MUX Custom instruments.

## Sensors tabs

Information about the sensor [Type](#) and [Model](#) is available at the [Sensor info](#) tab.

Available for: All sensors.



Type **Flow Sensor**

Model **1.50 µl/min**

If the physical connection of a sensor to an instrument is changed, modify it in the [Connected to](#) tab. The sensor can also be visualized in one or more other channels than the connected channels.

Available for: All sensors.



Sensor connected to	Channel	
OB1 MyInstr	1	<a href="#">Apply Sensor connection</a>

Sensor visualized in	Channel	
MyInstr	1	<a href="#">Edit Sensor visualized in</a>

To edit the visualization channel click on the [Edit Sensor Visualized in](#) button.

Available for: All sensors.



Available Channel

- MyInstr
  - MyInstr ch 1 (used by Flow!)
  - MyInstr ch 2 (free)
  - MyInstr ch 3 (free)
  - MyInstr ch 4 (free)

Selected Channel

- MyInstr ch 1 (used by Flow!)

→

←

[EDIT CHANNEL](#)

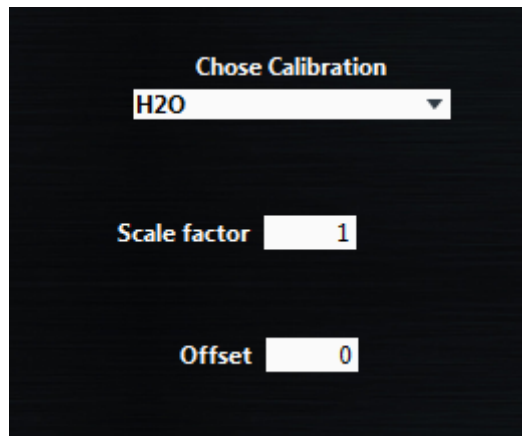
A list of all [Available channels](#) is listed on the left panels. Within brackets, the selected actual sensor is indicated. The selected channels are gray. The [Selected channels](#) are also listed on the right panel. Double click on a channel or use the right/left arrow to select/deselect it. If an instrument is double clicked, all the channels from that specific instrument are selected.

For specific applications the user may want to multiply the sensor readings by a [Scale factor](#) or displace it by an [Offset](#). These values are available at the [Scaling](#) tab.

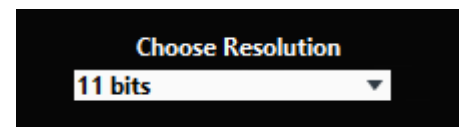
**Available for: All sensors.**

For some digital flow sensors, the calibration can be switched between H<sub>2</sub>O and Isopropyl alcohol using [Chose Calibration](#) field.

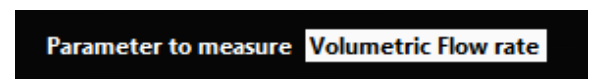
**Available to: Digital FS2, FS3 and FS4**



For all digital flow sensors, the sensor resolution can be chosen from 9 to 16 bits (default resolution 11 bits). Changing this resolution parameter will change the digital sampling time which is around 74 ms at 16 bits and 1 ms at 9 bits.



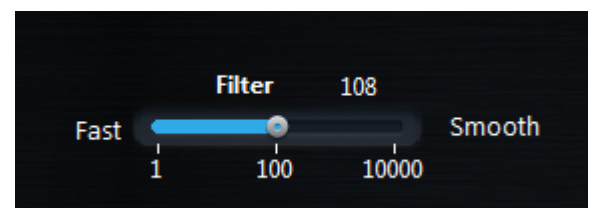
For BFS sensors, it is possible to change the displayed value to density, mass flow or temperature instead of volumetric flow rate. For digital flow sensors, volumetric flow rate and temperature are available.



At the [Level Sensor Configuration](#) tab, a [filter](#) can be applied. This filter provides a fast response if it's value is 1, but a single bubble will cause a voltage drop.

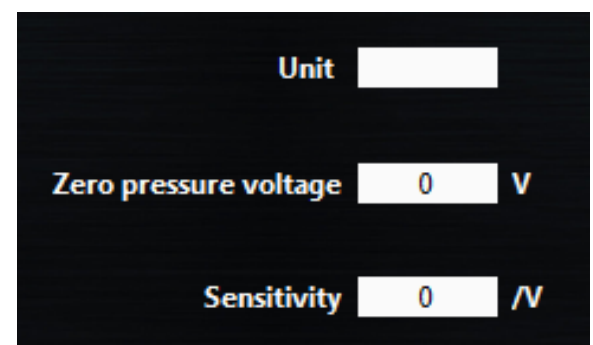
Smooth response can be obtained when the filter value is increased.

**Available for: Level Sensors.**



At the [Custom sett.](#) tab, a few extra parameters required for custom sensors can be configured: which [Unit](#) is used; at which voltage the sensor reads a [Null value](#); and how many units it should increase per volt ([Sensitivity](#)).

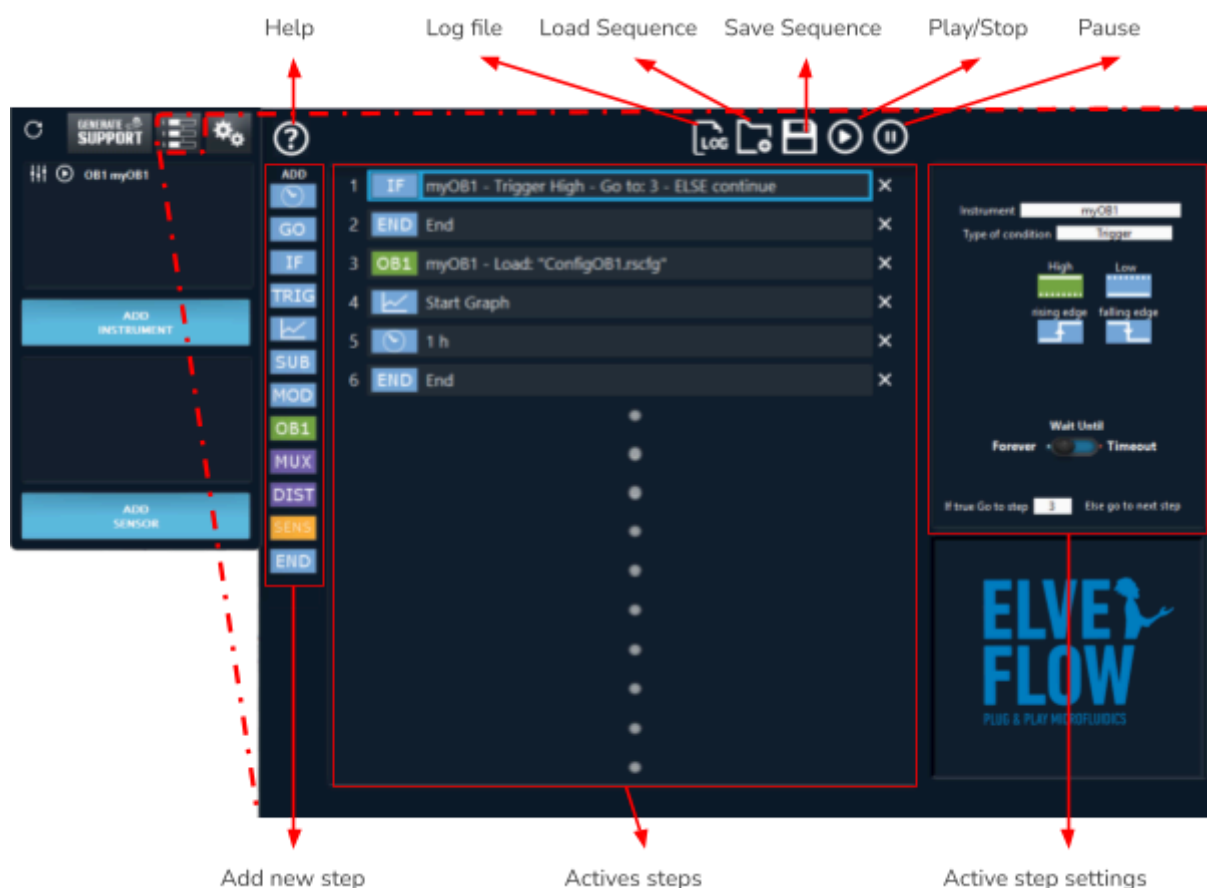
**Available for: Custom sensors.**



## Sequence

For automation purposes or synchronisation of an experiment, a sequence of events can be programmed in the dedicated interface. Click the [Sequence](#) button on the main window to open it. This section details all the steps. For concrete examples, refer to section [How To](#)

A standard view of this window with a short and simple sequence is represented below.



The window can be described as containing the following elements:

On the left side the [Add step](#) button. All steps will be described at the end of this section.

The darker panel in the middle shows the [Sequence](#) itself, with all steps.

The panel on the right presents the [Settings](#) of the active step.

On the top, from left to right, are the buttons to launch the [Help Windows](#), to choose a [Log](#) file to save sequence events, [Load](#) a sequence, [Save](#) sequence, [Start/Stop](#) and [Pause](#) the execution.

## How to create and edit a sequence

### Add a new step and configure it

Click on the step you want to add in [Add step](#). This new step will appear, in the [Sequence](#), next to the currently selected step.

Click in on this step in [Sequence](#) (panel 2); its actual settings will appear in the right panels.

Configure this step in the Active step settings panel (See [Steps Settings](#) ).

Repeat this operation as many times as required.

## Edit sequence order

Steps can be [dragged-dropped](#) to another position in the sequence.

Hold Ctrl and drag-drop to [copy](#) a step to a specific position.

## Delete Step

Delete a step by clicking the corresponding [X](#) button and by hitting the [Delete](#) key on the keyboard.

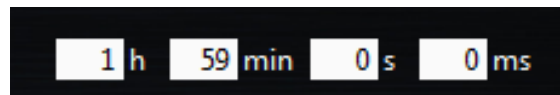


## Steps Settings

### Programming steps

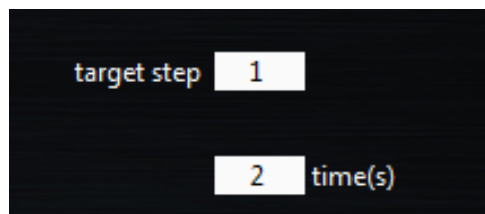
Wait 

[Wait](#) introduces a “hold” in the sequence. During the wait period, all instruments will keep executing their current tasks.



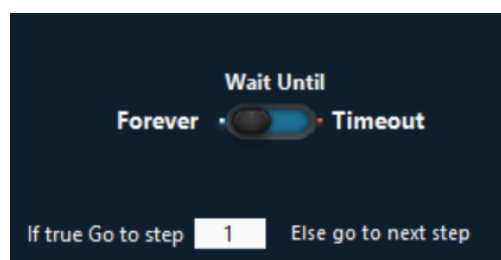
Go To 

[Go to step](#) can be used to jump to a step before or after the current step. Use this to create a loop or to avoid executing steps without having to actually delete them from the sequence.



If 

[If](#) step will add a condition in the sequence. Two [Type of condition](#) can be used depending on the type of instrument: Value or Trigger. If the condition is true, the sequence goes to the step defined in [Go to step](#).



As long as the condition is not met, the sequence will not move to the next step, and freezes indefinitely : the forever option corresponds to while loops in programming languages.



Since ESI V3.10.00 the forever option is set by default

A general timeout can be configured to wait for the condition to become true, **Otherwise it goes to the next step.** If a non zero time value is set, then the if function will go to the next step only after that time passed and that the if condition remains false. It is recommended to use it when synchronizing a sequence via an external trigger signal.

If Value is chosen, the Channel list allows you to choose the condition.


If Module is chosen, the step where the module is initialized (using MOD function) has to be chosen. Depending on the module chosen, you need to configure the step.

If Trigger is selected, select the type of trigger to be detected. For rising and falling edges the **time out** should be set (for High and Low the trigger status is only read once). Reading an edge has its own timeout of 100 ms.


Instrument

Type of condition


High




rising edge



Low



falling edge



Wait Until

Forever ☒ Timeout

If true Go to step  Else go to next step

Instrument

Type of condition

Channel

Compare to

Channel

Wait Until

Forever ☒ Timeout

If true Go to step  Else go to next step



### Helpful information about Trigger values

#### Trigger In (INT):

sent to the OB1 by a device, accessed either by

edge detection  
(falling or rising)

or via values:

-Low level: -0.3V to 0.8 V  
-High level: 2.0 to 5.8 V

INT trigger can only be accessed through the "IF" condition of the ESI sequencer.

#### Trigger out (EXT):

sent by the OB1 to another device

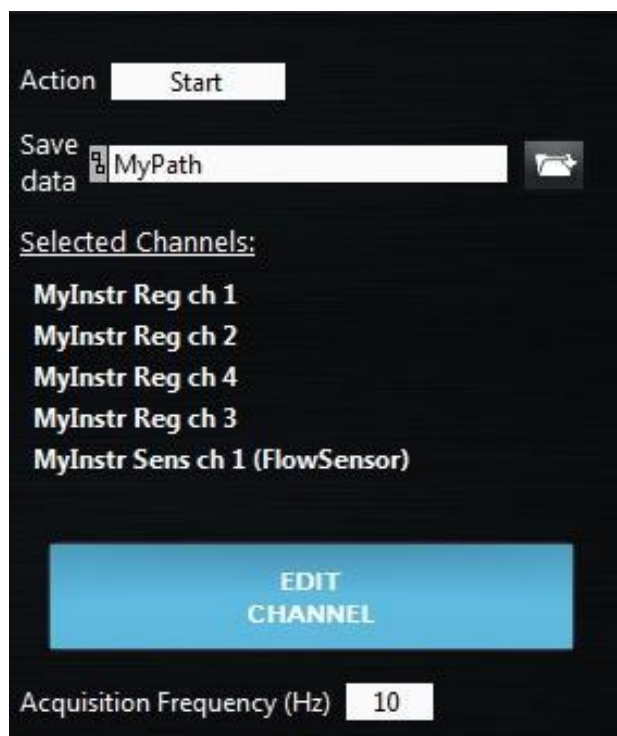
access via values:

-Low level: 0V  
-High level: 3.3V for OB1 MK3/MK3+, 5V for other instruments.

EXT trigger can only be accessed through the "TRIG" function of the ESI sequencer.

## Graph

Graph will start/stop a graph from the sequencer (depending on the [Action](#) status). The data will be saved in the path defined by the [Save Data](#) field. The actual [Selected channels](#) are listed below. The graph [Acquisition Frequency](#) can be changed from this panel. To edit the channels, click on the Edit [Channel](#) button. The Graph channel edition window (see Graphs section) will be opened.



## Sub Sequence

[Sub-Sequence](#) can be loaded from the sequencer. Select the subsequence path using the [Edit Path](#) button. The button [Edit Sub-Sequence](#) enables the edition of the selected subsequence. When a subsequence is edited a new button appears on the top of the Active Step Settings panel that enables the user to return to the main sequence.

## End

[End](#) will stop the actual sequence. Any time a sequence reaches an End step, it stops executing. If this step is used in a subsequence, it only stops the sub sequence and the main sequence continues.

## Module

[Mod](#) is used to initiate a module before using it in an [If](#) condition. So in any case you want to use a condition on a module, you need to have this step previously configured.

The only available modules in a sequencer are the bubble detector and the volume injection modules.



## Instrument control steps

Trigger **TRIG**

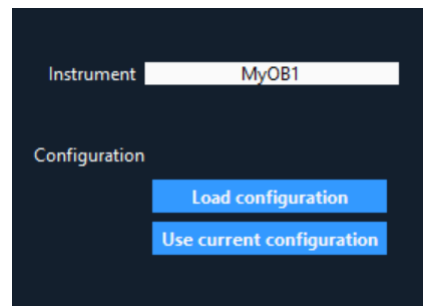
**Trigger** controls the trigger out of instruments. If high pulse or low pulse is selected, the pulse length can be set in this tab. For OB1 the high pulse is 3.3V. For other instruments, the high value is set to 5 V.



OB1, SENS and MUX **OB1** **SENS** **MUX**

**OB1**, **SENS** and **MUX** steps allow you to switch from one configuration to another. Read first the [Configurations](#) section ([Using configurations](#)). When adding one of these steps, first select the instrument (instrument field). Then click on [Load configuration](#) and select a previously saved configuration.

The actual configuration can also be used when clicked on the [Use actual configuration](#).



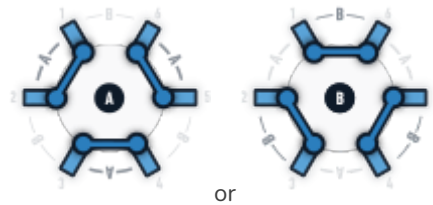
## MUX Distribution, Distributor, Recirculation or Injection (D-R-I)

**DIST**

MUX **DIST** step, for standard MUX Distribution (12 positions) or MUX Distributor (6 or 10 positions), the target **Valve position** can be directly selected. This valve will be activated when the step is reached.

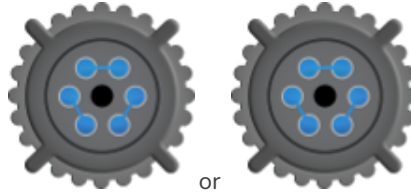
Valve position

For **Recirculation version** of the MUX, a button lets you select between the two positions.



or

For **Injection version** of the MUX, a button lets you select between the two positions.



or

## Advanced Settings

Some advanced options are unlocked only for advanced users. To activate those options, go to the general setting tab and activate **Advanced Sequencer option**. (See [General settings](#))

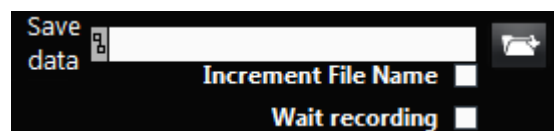
### Graph



The **Graph** step proposes two advanced options.

If **Increment File Name** is activated, the file names are automatically incremented. This avoids overwriting the file if graphs are called multiple times.

The **Wait for recording** option is activated; the graph will wait until the graph acquisition so start before going to the next step.



If

**IF**

The **If** step proposes to use Target value or real value.

✓ Select Channel  
PRESS ch1  
PRESS ch1(Target)

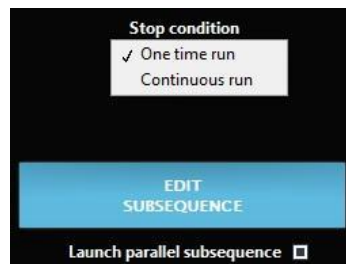


### IMPORTANT

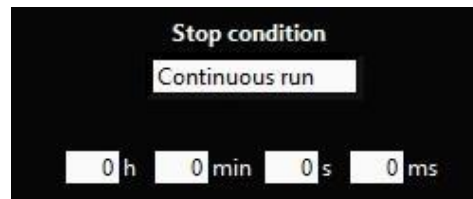
The target value for the sensor is only taken into account if the channel is configured in Feedback mode. If not the condition is set to false and the sequence goes to the next step.

## Sub Sequence SUB

The Sub-Sequence step proposes to use Launch parallel subsequence with two stop conditions, either One time run or Continuous run.



The Launch parallel subsequence allows you to run a subsequence without waiting for its end to continue the main sequence. You can either run the subsequence one time to execute the subsequence while the main sequence is running or choose Continuous run to run the subsequence continuously during a determined time (chosen below) while the main sequence is running.



Running sub-sequences are listed when you execute the sequence. If a sub-sequence is not listed it means that the sub-sequence is not running. Only the sub-sequences launched using Launch parallel subsequence are listed.



Sub-sequences can be stopped at any time by clicking on the cross in the Running subsequences list.



### IMPORTANT

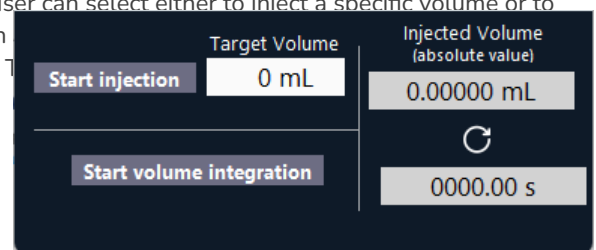
Graph cannot be used in sub-sequences launched this way.

## Modules

Modules are extra functionalities that could be added to instruments. They can be accessed from the [add module](#) button (See [Modules](#) )

### Flow injection/integration module (requires a flow sensor)

The injection module allows injecting a given volume of sample. To do so the user can select either to inject a specific volume or to continuously monitor an injection. The [Target injection volume](#) can be set in [volume](#) value. The start button allows you to start/pause the injection process. The

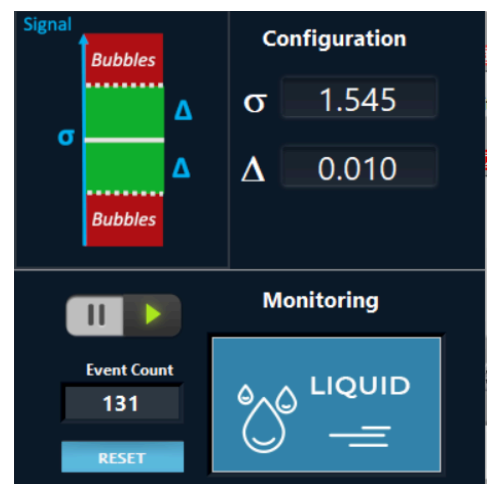


#### IMPORTANT

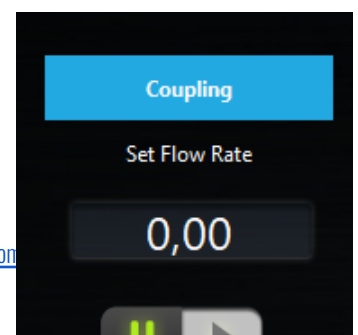
- If a [flow sensor](#) is connected to the flow path (or to the central line of MUX distribution valve) and to another instrument such as an OB1 or a Sensor Reader, -which can read its data- this injection module can integrate the volume flowing through the flow line connected to the sensor.
- At the end of the injection, the channel control mode is switched to "Sensor" (feedback control using flow sensor) and the target flow is set to zero.

### Bubble detection module (requires a bubble detector)

The bubble detection module allows the user to detect if bubbles are flowing into tubes. To do so you can select the [Limit Value Bubble Detector  \$\sigma\$](#) . It is the value you obtain when there is no bubble in your system; if this value is 0 when your system is filled up with water, use the calibration button on your bubble detector. The [Standard Deviation  \$\Delta\$](#)  is the fluctuation around the [Limit Value Bubble Detector  \$\sigma\$](#)  where you consider that the value still corresponds to water.



### Coupled Flow rate module (OB1 with flow sensor)





### IMPORTANT

To open the coupled flow rate module, select the channel you would like to use as the main channel with a flow sensor. The control mode of this channel will automatically turn to “Sensor” mode.

The coupled flow rate module allows the User to [Set Flow Rate](#) on the channel dedicated and modifies [Coupling](#) with other channels to do a feedback loop with one flow sensor and multiple pressure outputs.



### IMPORTANT

Remember to adjust the setup resistance and your PID parameters as usual in Sensor mode.

The [Selected channel](#) is the main channel you will use to couple other channels. [Tubing ID](#), [Viscosity \(Pa.s\)](#) and [Tubing length \(mm\)](#) depend on the tubing/solution used to connect your main channel to your microfluidic system. Then [Theoric multiplication Factors](#) can be set (1 to have the same amount of pressure on each channel) as well as [Tubing ID](#), [Tubing length \(mm\)](#) and [Viscosity \(Pa.s\)](#) for each other channels.

Then the user can press calculate to obtain the [Corrected Factors](#) that will be used to regulate flow rate. Users can click on [Apply Corrected Factor](#) and close the window to set up the corrected factors.

Selected channel	Coupling channels	Theoric multiplication Factors (0=no coupling)	Tubing ID	Tubing length (mm)	Viscosity (Pa.s)	Calculate	Corrected Factors
OBI Ch. 1	OBI Ch. 2	0	1/32	0	0.00100		
Tubing ID 1/32	OBI Ch. 3	0	1/32	0	0.00100	0	
Viscosity (Pa.s) 0.00100	OBI Ch. 4	0	1/32	0	0.00100		
Tubing length (mm) 0							0

Apply Corrected Factor

## Help Window

You can find a question mark button on the top of the Windows sequencer. This button opens a window (see figure below) called the [Help window](#). It shows the different sequencer steps with some explanation on how to use them. There are also a number of examples, with instructions on how to create sequences easily.



## Keyboard shortcuts

### General

In any control window in which [Configurations](#) are available use [Ctrl + <number>](#) to switch between configurations. The numbers correspond to the position of each configuration on the list.

The [space bar](#) will toggle the [ON](#) button in an active channel or MUX control window.

### OB1

Use the [Shift+left](#) and [Shift+right arrows](#) to navigate between channels.

Use the [up](#) and [down arrows](#) to increment/decrement the actual value.

The [Escape](#) key will switch off all channels.

### OB1, MSR, BFS

To launch a graph, hit [G](#).

### Sequence

[Arrow-up](#) and [arrow-down](#) help navigating through the sequence steps.

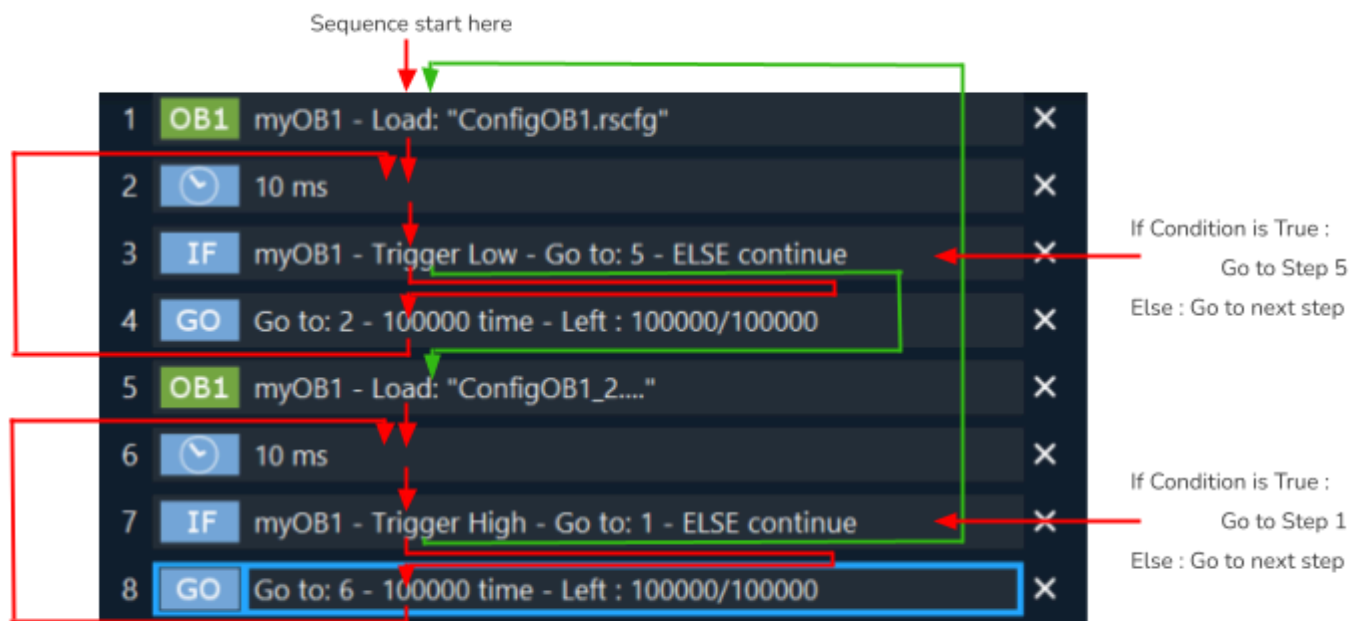
The [delete](#) key will remove the selected step from the sequence.

## HOW TO...

### ... use “IF” and “Go To” Step

This section explains how to use conditions and loops in the sequence using a simple example.

In our example, we connected an OB1 named MyInstrument. We would like to change the configuration according to the trigger state ( trigger High  $\square$  CongifOB1.rscfg, Trigger Low  $\square$  CongifOB1\_2.rscfg) . The following sequence was built for that purpose.



Step 1 – Set the OB1 configuration to CongifOB1.rscfg

Step 2 – Wait 10 ms (decrease CPU consumption time)

Step 3 – If the trigger is Low, change go to step (to change the OB1 State), else go to next state (To stay in the loop)

Step 4 – go back to step 2 – many times (depending on the experiment duration)

Step 5 – Change the OB1 State to CongifOB1\_2

Step 6 – Wait 10 ms (decrease CPU consumption time)

Step 7 – If the trigger is High, go to step 1 (to change the OB1 State), else go to next state (to stay in the loops)

Step 8 – go back to step 6 – many times (depending on the experiment duration)

## Use the ESI Sequencer to automate your experiment

We will consider the example below to illustrate how the ESI Sequencer can be used..

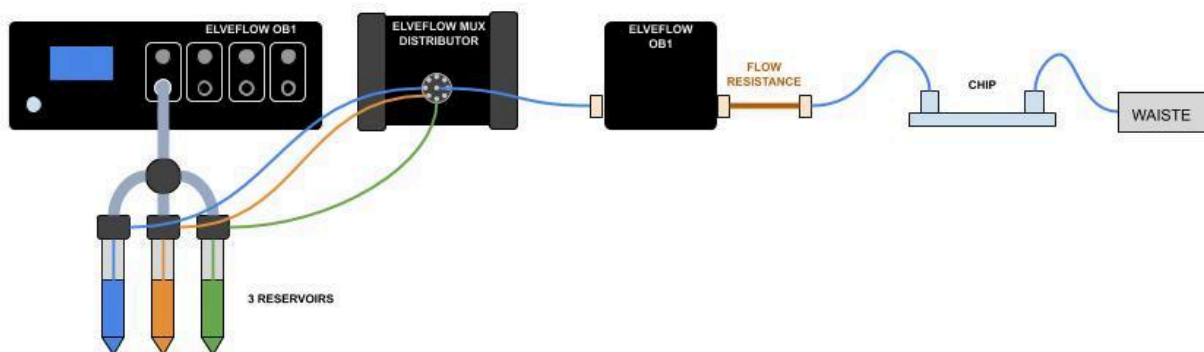
### The experiment

Say you have 3 different media, and you want to inject each solution one after another into your chip. You may want to use different pressure for each medium, like e.g.:

- Channel 1: pressure 40 mbar for 1 hour
- Channel 2: pressure 1000 mbar for 5 minutes (to replace the previous medium as fast as possible)
- channel 2: pressure 40 mbar for 1 hour
- channel 3: pressure 1000 mbar for 5 minutes (to replace the previous medium as fast as possible)
- channel 3: pressure 40 mbar for 1 hour

### The setup

Your setup could look something like this:



Please note that a Flow Resistance with relevant characteristics (ID, length) is very often required to stabilize the flow rate in flow control mode. Also PID parameters tuning is required too, to ensure the best flow control performance, please refer to the section above about the Resistance Module, and the MFS User Guide.

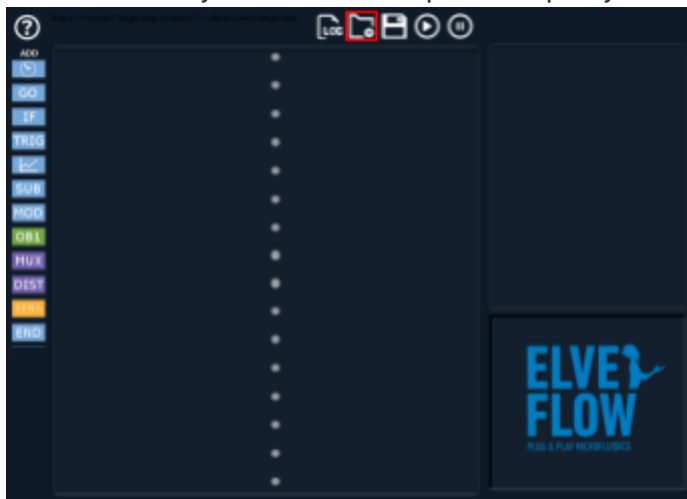


## The steps

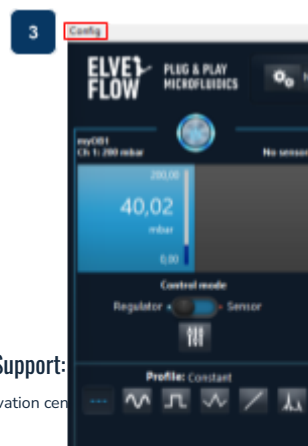
1. Start the ESI software.
2. Then, open the sequencer panel.

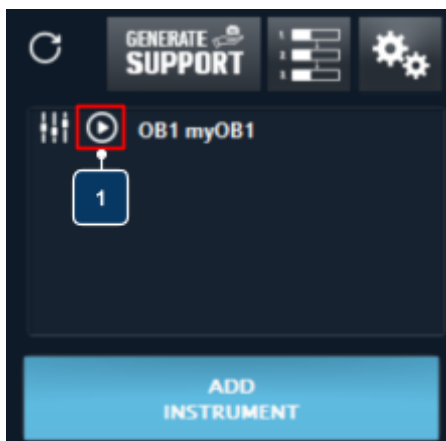


3. Then once here you can load a sequence .sq file you created earlier.

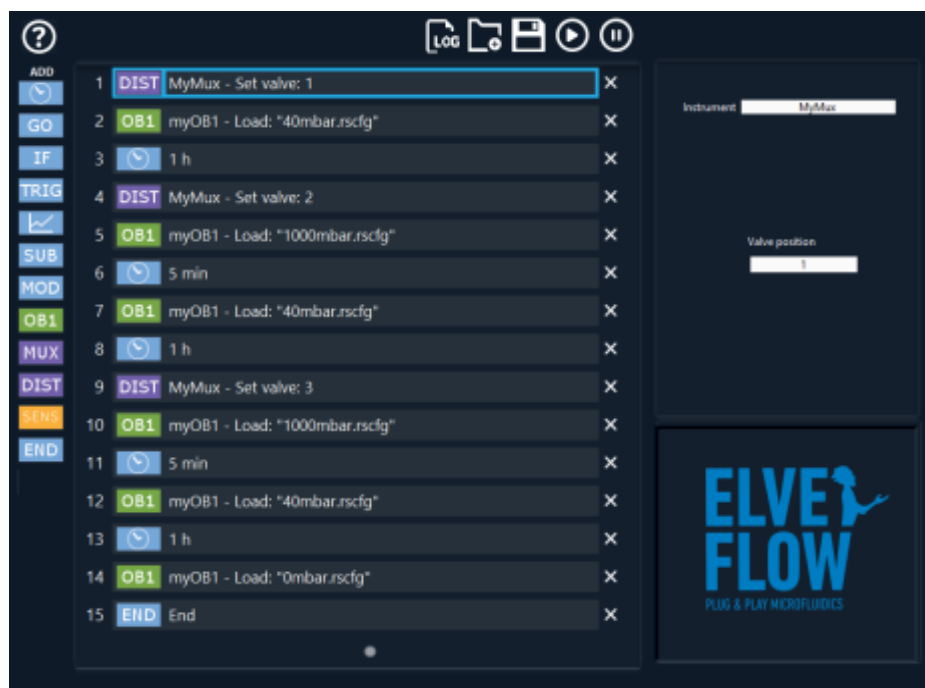


3.1 Or you can start creating a new sequence. If yes, open your OB1 main panel , edit your OB1 conditions (e.g. 40 mbar) then click on "Config " at the top and "Save As" (name it 40 mbar for example).



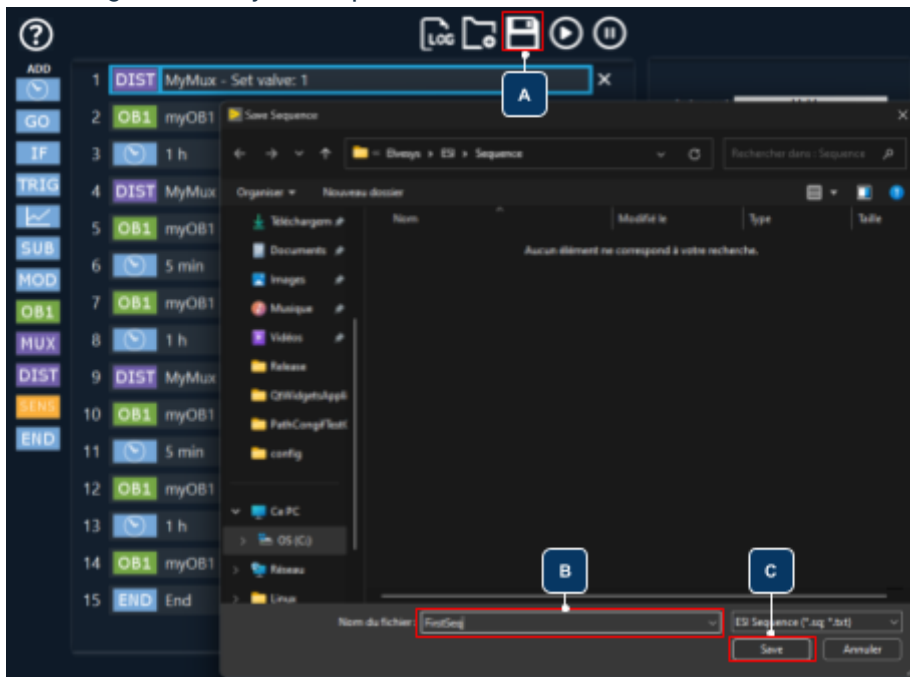


4. Do the same with a set pressure at 1000 mbar then click on "Config " at the top and "Save As" (name it 1000 mbar for example).
5. Now you can add steps in the sequencer. Start with the Mux, select your instrument and valve and continue adding steps, according to the strategy you defined. The complete sequence should look like this. steps 1-15.



6. Please note that you need a configuration with OB1 pressure set at 0 mbar to easily end your experiments. Also an END step may be a good thing.

7. Don't forget to Save your sequence.



Please note that sequences are setup dependent, i.e. they refer to the exact instruments names given and exact computer files paths. As a consequence, a sequence made using a specific OB1 can't be used to perform the same experiment using a different OB1.