Software user manual - TUS sensor

NANOPAT V 0.7.6

IRIS TECHNOLOGY SOLUTIONS, S.L.
Carretera d'Esplugues 39-41
08940 Cornellà de LLobregat, Barcelona – España
+34935542500 www.iris-eng.com

IRIS Technology Solutions

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02	06/07/2022	Susana Gómez	New functionalities
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04	24/03/2023	Susana Gómez	Introduction & contents added

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Introduction

This document is a user manual for the Software, developed by IRIS TECHNOLOGY SOLUTIONS, S.L., which acquires and processes data measured with the TUS sensor. It also controls the dilution if applicable.

The objective is to measure the size of the nanoparticles. The software controls the spectrometer and carries out algorithms on the spectra to calculate the size of the nanoparticles. It also controls the dilution system.

It is preferred to run the software as administrator to save all the configurations properly.

The software contains three different pages that allows the user to control the sensor as well as the pumps on the dilution system.

Home page

The home page is the monitoring page, where the user can continuously monitor the spectra and the nanoparticles size over time.

There are two different modes of operation: dilution and no dilution measurements that can be selected using the button shown on Figure 1.

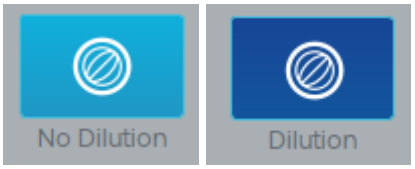

Figure 1: Dilution selector.

Both modes need a reference that can be taken using the button “Reference” and the reference dialog.

Reference

Clicking the reference button (see Figure 2), the reference dialog (see Figure 3) will appear allowing the user:

- To take a reference (“Measure”)
- To save the currently displayed reference in a file (“Save to file”)
- To upload a previously saved reference from a file (“Upload”)
- To change the integration time

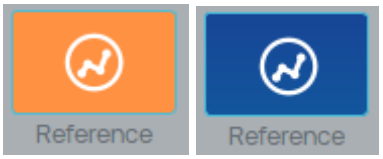

Figure 2: Reference button.

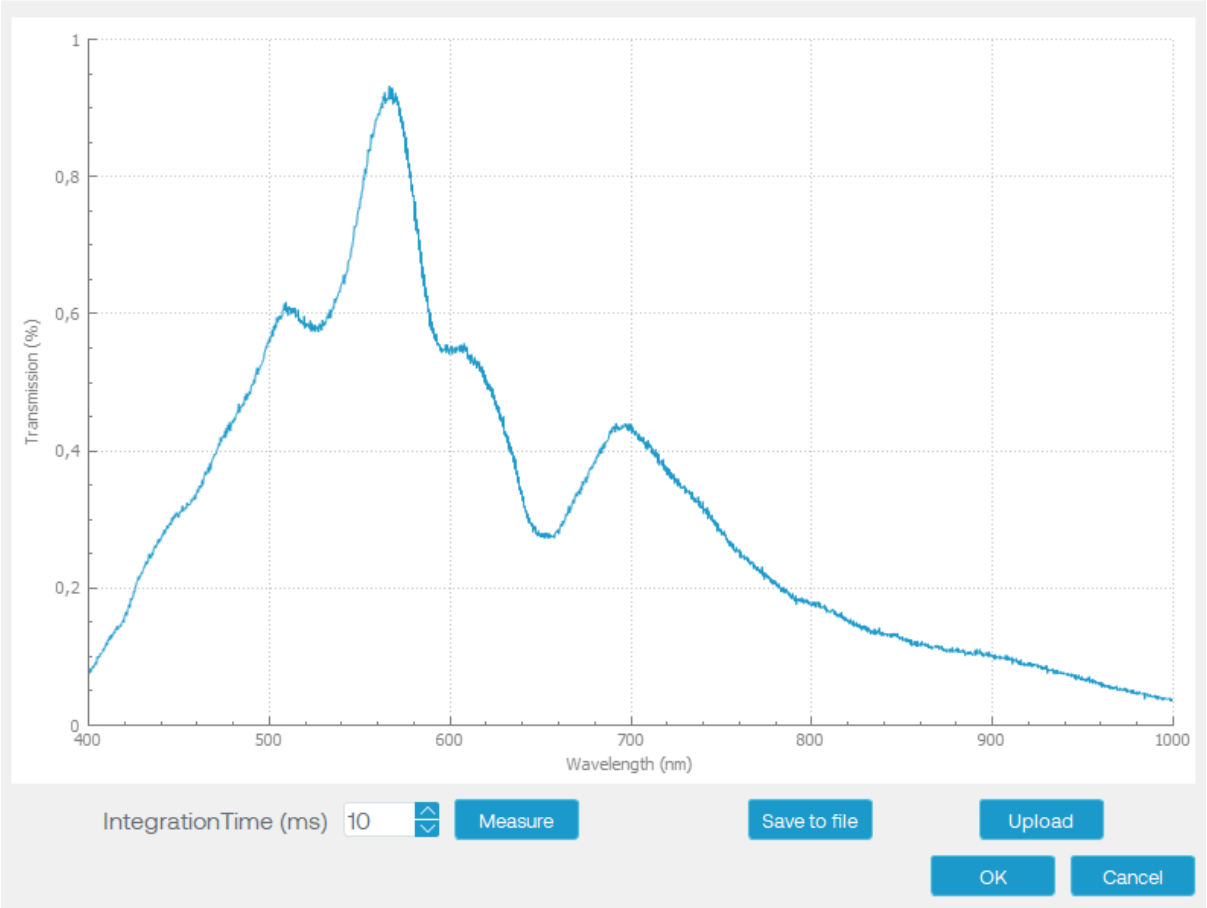

Figure 3: Reference dialog.

Dilution measurements

The dilution mode is an automated process that, apart from measuring the nanoparticle size, also controls the pumps' speeds to optimise the dilution of a nanoparticles sample with water. The dilution will take place while the transmission is outside the intervals configured in the "Config." page.

The dilution mode allows to take measurements continuously in a frequency configured in the "Config" page. In order to start the measurements, select Dilution (see Figure 1) and then click the ON/OFF button as shown in Figure 4.

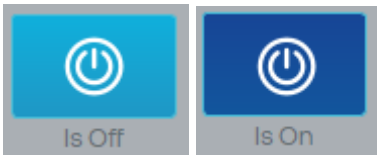

Figure 4: ON/OFF button

If the PLC is not connected, the measurements won't be taken.

The particle size of every measurement is added to the “Particle size evolution” chart. Also, the current calculated value of the nanoparticle size and wavelength exponent are displayed under “Particle Size” on the “Results” section (see Figure 5).

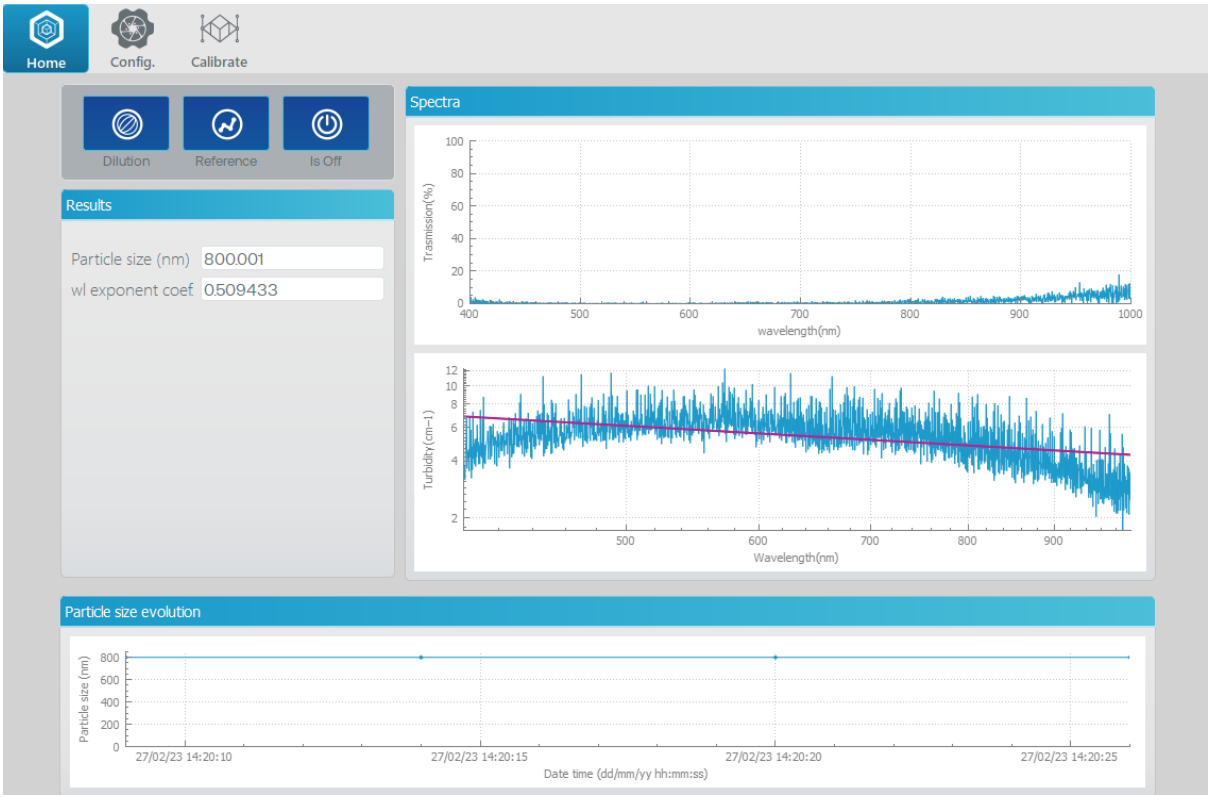

Figure 5: Dilution view.

The current transmission percentage and turbidity is displayed as well.

The user can stop the dilution process at any time by pressing the Off button and a warning will appear (see Figure 6). The system will perform an automatic cleaning.

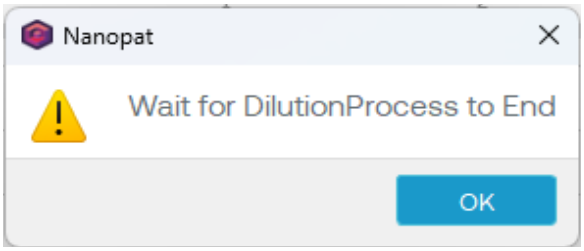

Figure 6: Warning when the dilution is stopped by the user.

It is important to manually stop the dilution and perform a manual system cleaning from the “Calibrate” window to keep the system clean, in the following cases:

- Communications with the PLC are interrupted (a message will appear in the “Info bar” at the bottom of the window).
- The program suddenly closes.

No dilution measurements

The no dilution mode allows to take measurements continuously in a frequency configured in the “Config” page. In order to start the measurements, click the ON/OFF button as shown in Figure 4.

The particle size of every measurement is added to the “Particle size evolution” chart. Also, the current calculated value of the nanoparticle size and wavelength exponent are displayed under “Particle Size” on the “Results” section (see Figure 7).

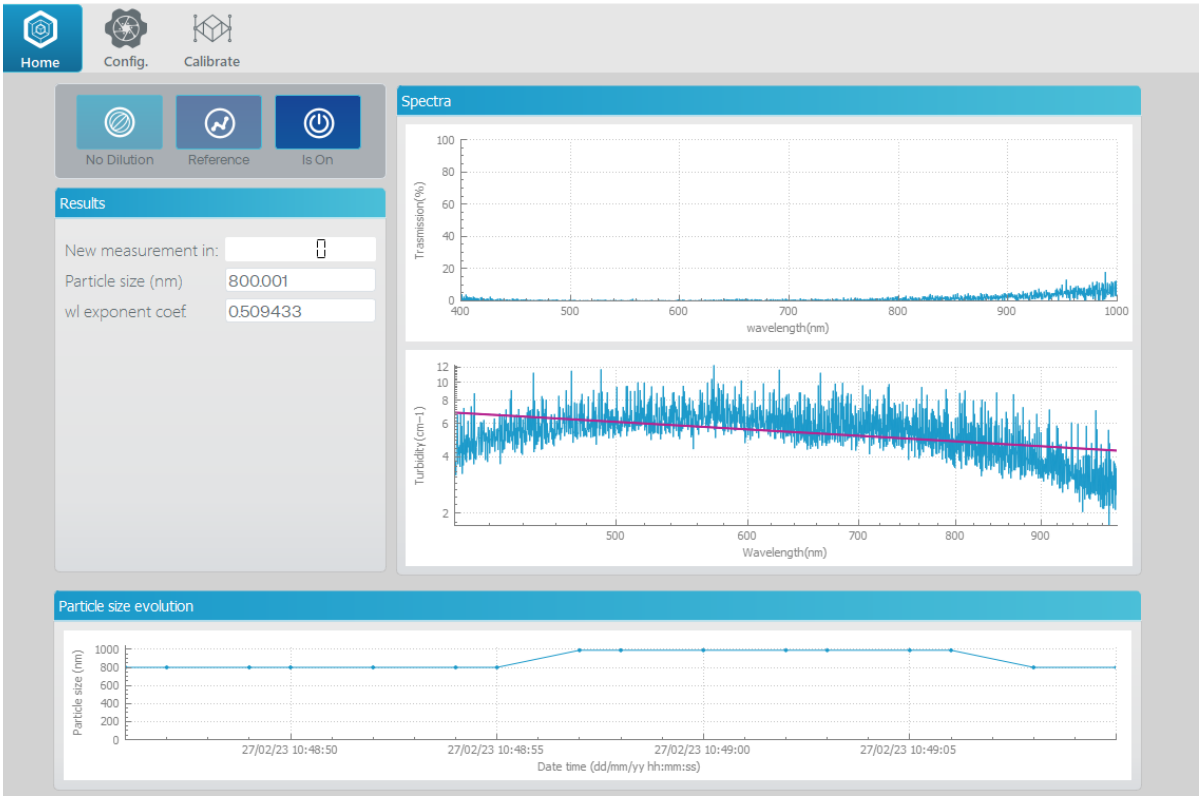

Figure 7: No dilution view.

The current transmission percentage and turbidity is displayed as well.

Configuration page

The configuration page is divided into two tabs: “Acquisition Settings” & “Pumps”.

Within “Acquisition Settings” the “TUS sensor” configuration, “Other Settings” and “Automatic Modes Settings” can be found (see Figure 8).

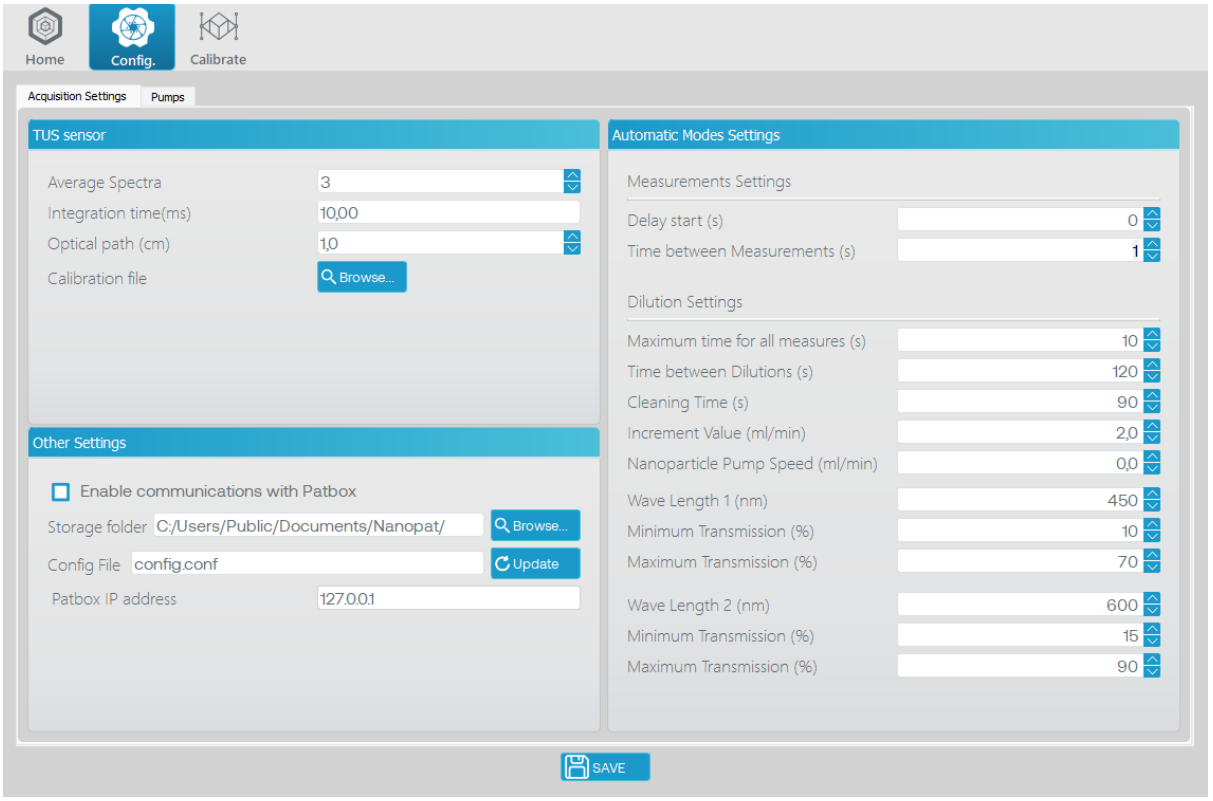

Figure 8: Configuration page: Acquisition Settings

It is possible to load or save the configuration using the buttons available:

- “SAVE” will save the current configuration. However, if other changes are made, these won’t be automatically saved in the saved file. The changes will be kept in the file under “Config File”.
- “Update” will load into the system a previously saved configuration, although the changes will be applied after restarting the program.

TUS sensor configuration

These parameters involve the configuration of the spectrometer as well as the algorithm used to calculate the nanoparticles size.

⚠ To apply the changes, clicking outside the modified field is a must.

Average spectra: number of the spectra read from the sensor and averaged to use in one single measurement. The average spectra will affect the signal noise and the time required to take a single measurement.

Integration time: the amount of time that the spectrophotometer is allowed to collect information.

Optical path: distance crossed by the light in a liquid solution.

Calibration file: file used to calculate the size of the particles. The program won't start if it doesn't have a calibration file uploaded or there are blank lines. It is recommended to restart the program every time a new calibration file is uploaded. This way the correct calibration file will be automatically saved in the folder where the continuous measurements are saved.

Other Settings

The configurable parameters are:

Enable communications with Patbox: allows communication with the IRIS Process Analytical Technology (PAT) system management software.

Storage folder: every time the program is opened, a new folder is created in this path where the continuous measurement for every measurement in continuous mode, a file is created with the reference, the raw spectra, the normalised spectra, the turbidity and wavelength exponent and particle size. These files can be used to perform offline analysis and to improve the accuracy of the algorithm that calculates the size of the nanoparticles. These files are saved in the folder configured in this field.

Config. File: the configuration settings used and updated. This file must be saved in the Nanopat program folder.

Patbox IP address: IP address to communicate with PATbox.

Automatic Modes Settings

This section is divided into parameters that only affect the dilution and those which only affect the no dilution mode.

Delay start (s): the time after which the measurements will start.

Time between Measurements (s): time between two measurements in no dilution mode. The minimum possible time is 10s because it is what it takes to acquire and save the measurement.

Maximum time for all measures (s): it is the maximum time spent diluting in every cycle. If the desired transmission is reached before, then the system jumps to cleaning mode.

Time between Dilutions (s): time past between two dilutions. Depending on the values on "Maximum time for all measures" and the "Cleaning Time", this time has a minimum value possible and the program won't introduce a lower value.

Cleaning Time (s): time spent cleaning in both dilution and no dilution mode.

Increment Value (ml/min): increment or decrement of the water pump flow rate in order to reach the specified transmission during dilution.

Nanoparticle Pump Speed (ml/min): flow rate of the nanoparticles pump

Wave Length 1 (nm): first wavelength at which the transmission must be between 2 values.

Wave Length 2 (nm): second wavelength at which the transmission must be between 2 values.

Minimum Transmission (%): for each of the wavelengths above, it is the lower limit of transmission to reach the desired dilution ratio.

Maximum Transmission (%): for each of the wavelengths above, it is the upper limit of transmission to reach the desired dilution ratio.

Pumps

In this section, the communication with the dilutions pumps and the PLC is established.

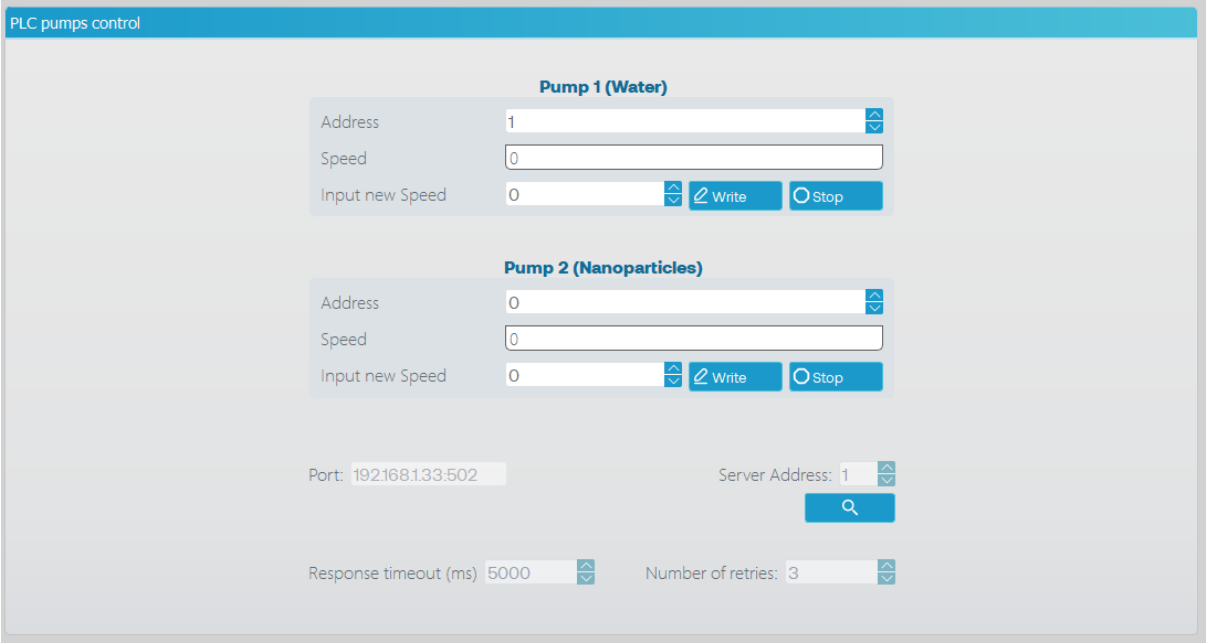

Figure 8: Configuration page: Pumps

⚠ This configuration should not be modified because it can cause the failure of the communication with the PLC. Only trained personnel can do it.

The common parameters are:

Port: IP address to connect to the PLC.

Server Address: modbus communication address defined by the specific PLC.

Response timeout(ms): time to wait before considering that the connection with the PLC has failed.

Number of retries: number of retries before considering that the connection with the PLC has failed.

For each pump, there are three parameters that can be configured:

Address: the PLC registry address where the speed of the pump is configured.

Speed: Speed of the pump.

Input new Speed: Field to input a new speed in bit units. Note that this field should only be used for testing purposes by IRIS staff.

Button write: to set up the speed of the pump on the PLC registry.

Button stop: to stop the pump.

Calibrate

The calibrate page allows the user to take single measurements manually with and without diluting (see Figure 9).

This page can only be used while the continuous measurement is off. If the PLC is not connected, the pump's control is not allowed.

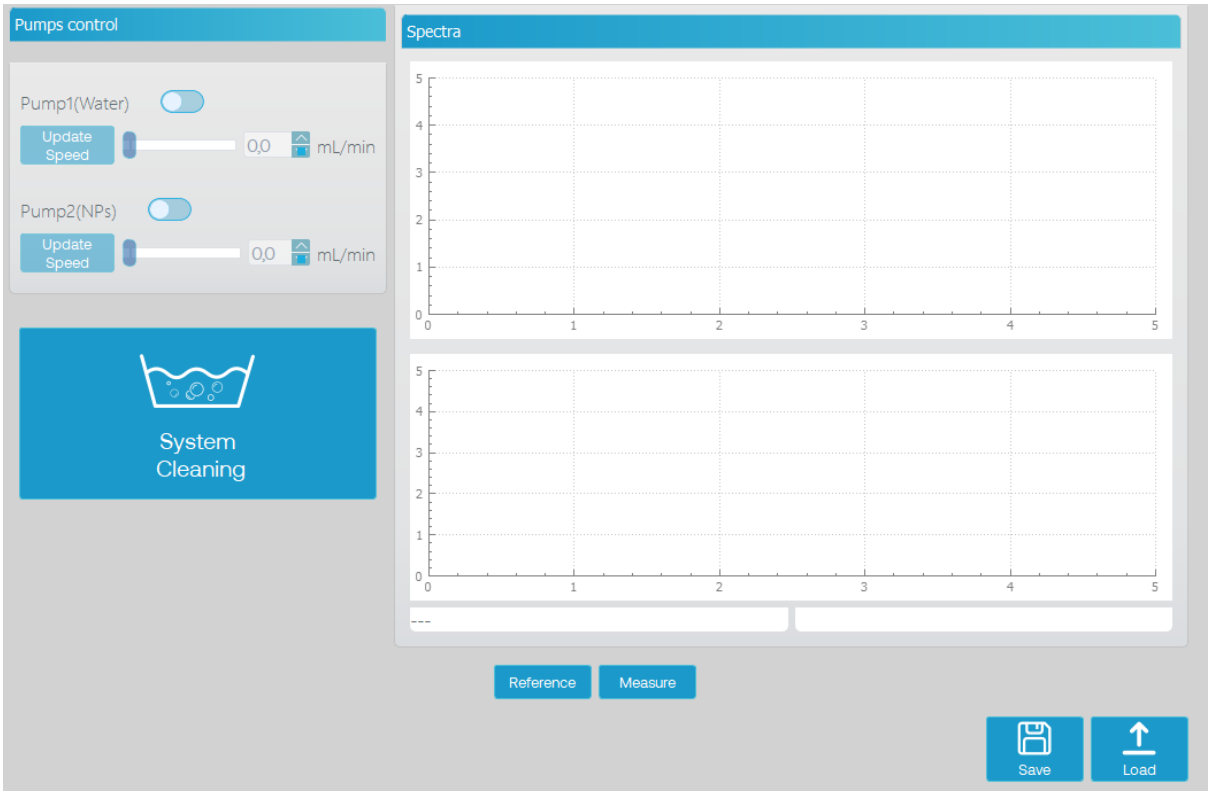

Figure 9: Calibration view.

Pumps control

Allows the user to modify the speed of the water and nanoparticles flow.

In order to turn on and off any of the pumps, it is necessary to click the slider. Once the pump is on, the speed can be modified by either sliding the bar or typing the flow rate in the field. After that, press “Update Speed” to send the new speed to the pump.

Action Buttons

Reference: opens the reference dialog.

Measure: take a single measurement.

System cleaning: performs a manual cleaning of the pipes by pumping water. The cleaning time can be modified in the “Config.” window.

Save: Save the measurement into a file.

Load: Load a previously saved measurement into the system allowing to calculate the size of the nanoparticle.

Info Bar

At any time, while the application is running, there will be an info bar at the bottom (see figure 10).

Figure 10: Info bar

From left to right there are 5 indicators:

Patbox Conexion Status: Indicates whether the system is connected (green) or not (grey) to Patbox application.

Measures Alert: Indicates if there is any problem taking measurements (orange) or not (grey).

Communication with PLC Status: Shows if there is any problem in the communication with the PLC when this is connected. Automatic Dilution Mode, manual pumps control and cleaning operation require this indicator to be in green state.

PLC connection Status: Indicates if PLCis connected or not

Other warnings: for other warnings an specific text with the warning will be displayed, problems in the communication, problems taking references or measures, or problems extracting data from transmission char (that is the case of the Figure 10 text “Transmission values outside the set values” that indicates that transmission values taken can not be used to calculate the particle size or wavelength exponent, usually due to a too noisy transmission chart).