M212324EN-B

RESTRICTED

WindCube Scan software suite User Manual

Version 20.a

LEOSPHERE
A VAISALA COMPANY

PUBLISHED BY

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Table of contents

List of figures

List of tables

1. About This Document

1.1 Version Information

Thank you for choosing WindCube 100S-200S-400S for your wind measurement activities. The LIDAR has been designed to ensure you a reliable and easy way to perform 3D wind mapping. We wish you success in its use and hope that it will contribute to the progress of your projects.

This user guide aims to assist the client in using the WindCube Scan software suite and describes its main features.

This user manual is for information purpose only and its content is not contractual. Should the product evolve in the future, necessary changes to this document will be incorporated in the next editions.

This version of the manual corresponds to the WindCube Scan software suite - version 20.a. This package consists of :

- Software of Windforge server version 3.2.0
- Windforge GUI 3.2.0
- **API** version 1.1.0
- Tools version 1.0.0
- OS version 3.2.0

- Windforge server: server software package, embedded in the Lidar

- Windforge GUI: client software package, installed on the client PC

- **API**: Application Programming Interface server package, embedded in the Lidar

- Tools: other software package, installed in the Lidar

- OS: Operating System package, installed in the Lidar

Table 1 Document Versions

Document Code	Date	Description
M212324EN-C	July 2020	Third version.
M212324EN-B	January 2020	Second version.
M212324EN-A	Septembre 2019	First version.

1.2 Related Manuals

Table 2 Related Manuals

Document Code	Name
M212324EN	WindCube 100S/200S/400S Software User Manual Renamed as: WindCube Scan software suite
M212326EN	WindCube 100S/200S/400S Hardware User Manual
M212502EN	Windcube 100S/200S/400S Software User Manual with WALS Renamed as: WindCube Scan Wind and Aerosol Post Processing software suite

1.3 Documentation conventions

WARNING! Warning alerts you to a serious hazard. If you do not read and follow instructions carefully at this point, there is a risk of injury or even death.

CAUTION! Caution warns you of a potential hazard. If you do not read and follow instructions carefully at this point, the product could be damaged or important data could be lost.

Note highlights important information on using the product.

Tip gives information for using the product more efficiently.

Lists tools needed to perform the task.

Indicates that you need to take some notes during the task.

1.4 Trademarks

The WindCube technology has been developed in cooperation with the Applied and Theoretical Optics Department (DOTA/SLS, ONERA, France). Your product is made in France.

ONERA has granted an exclusive license for the manufacturing of the WindCube to Leosphere. Leosphere, WindCube and WindCube Nacelle are registered trademarks of Leosphere SAS (respectively trademark registration numbers 1377780, 4924957 and 3832860).

All other product or company names that may be mentioned in this publication are trade names, trademarks, or registered trademarks of their respective owners.

2. Scanning Windcube Overview

2.1 WindCube Scan Software suite presentation

The WindCube Scan Software suite is supplied with the system, and provides a graphical user interface that enables the user to pilot and monitor the scanning LIDAR.

The measurement data are retrieved in real time and displayed by the WindCube Scan Software suite. Data are also stored in a database hosted on the LIDAR and may be retrieved by the WindCube Scan software.

The benefits of the WindCube Scan Software suite are:

- A modern graphical user interface designed to simplify the operation of the Lidar with minimum training requirements.
- A reliable data management based on a **SQL** database that enables easy access to stored data through requests and an easy interface with third party software solutions.
- A real-time audit system of the status of all Lidar system components, via the administration interface.

2.2 Measurements provided by the scanning Windcube

The scanning Windcube can provide the following measurements (depending of the scans):

- **Radial Wind Speed**
- **Dispersion Radial Wind Speed**
- Wind reconstruction
- Carrier to Noise Ratio (**CNR**)
- **Spectrum** (optional)
- **Attenuated Relative Beta** (optional)
- **Attenuated Absolute Beta** (optional)
- Aerosol and cloud detection and discrimination (optional)
- Detection of the Planetary Boundary Layer (**PBL**) height (optional)

2.3 Type of scan

The WindCube Scan software suite permits to create, edit and play a range of scans:

- **PPI** scan (« **P**lan **P**osition **I**ndicator »): constant **elevation angle** scan
- **RHI** scan (« **R**ange **H**eight **I**ndicator »): constant **azimuth angle** scan

- **DBS** scan (« **D**oppler **B**eam **S**winging technique »): point the beam at 5 different lines of sight (**LOS**) including 4 **LOS** spaced 90° apart with a fixed **elevation angle**, and one vertical LOS.
- **FIXED** scan (**F**ixed **L**ine **O**f **S**ight): point the beam at 1 direction during a defined time. It includes the case of **PBL** option
- **Composite**: made of several scans

A scan can be played at user request in endless loop by the software. A scan can also be played at a scheduled time, either once or periodically.

2.4 Software architecture

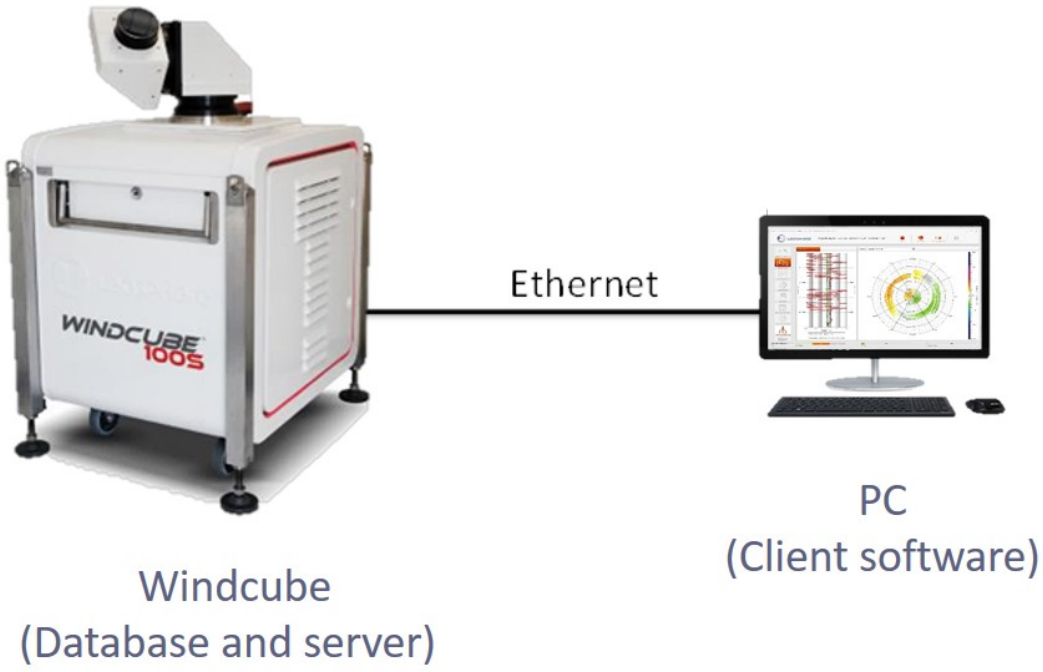


Figure 1 Software architecture

The WindCube Scan software suite has been designed to maximize the system availability. A scanning WINDCUBE can be configured and monitored from a LAN (**L**ocal **A**rea **N**etwork), using TCP/IP protocol:

- An implemented client-server architecture (server running on CentOS) that allows the Lidar unit to be fully and efficiently dedicated to acquisition and data processing, and thus increases its robustness.

2.5 WindCube Scan API

A scanning WindCube can also be managed with an **API** (Application Programming Interface). It allows you to manage your Scanning Lidar and retrieve data automatically without using the GUI.

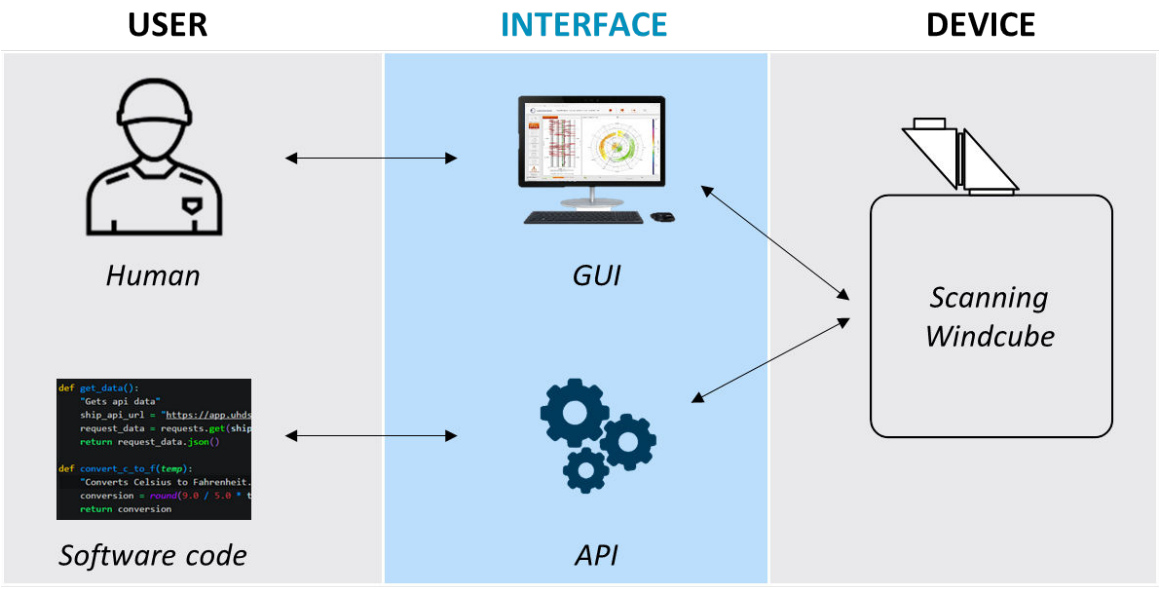


Figure 2 Windcube API

Based on simple REST principles, the Leosphere Web **API** server returns JSON data, or files like logs or **NetCDF** data files and allows automatizing most of the actions you can perform with your Graphical User Interface (GUI).

This **API** is organized around 5 categories of actions:

- Authentication: Connection management
- Data: Wind and Aerosols data retrieval
- Monitoring: Lidar's monitoring through status, activities environmental data and logs retrieval
- Configuration: scans, settings and resolution management
- Control: Lidar's acquisition control and programming

The **API** documentation is accessible, with any browser by typing the following address on a computer connected to your Lidar: `http://YourLidarIpAdress/doc/`

The latest documentation is also available online at https://leosphere.github.io/LeosphereAPI/.

More information

‣ Leosphere API (page 156)

2.6 Software installation

An installation file has been provided with this manual for the client software.

CAUTION! Before any upgrade of the software, check if you need to export your data. We recommand to export your wind data beforehand as it will be deleted from the database. Leosphere cannot be held responsable in case of data loss.

1. Copy this file to a temporary folder on the computer that will be used for the LIDAR monitoring and launch the Wind Lidar Software Setup.
2. When prompted, select **OK**.
3. Then, follow the instructions:

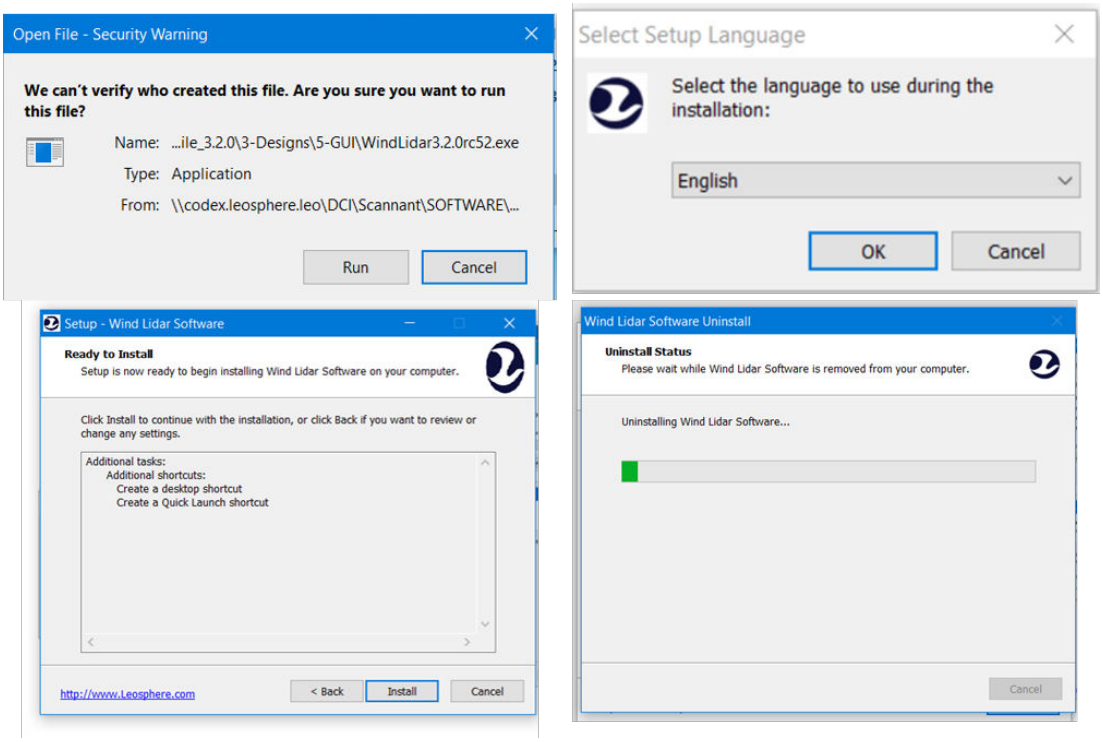


Figure 3 Software installation

At the installation of WindCube Scan Software suite (version 20.a), the upgrade to postgres 11 is carried out which allows the perenity of the system and the continuity of the security.

3. Connect and access to the Lidar

3.1 Connecting to the Lidar

The WindCube Scan software suite must be installed on the user's computer.

The default passwords are identical to the profile name.

Table 3 Connection's default passwords

Login	Default password
`viewer`	`viewer`
`standard`	`standard`
`expert`	`expert`

CAUTION! To ensure a better level of security, we recommend changing these passwords at first login (expert profile access needed).
The **Password** of an account cannot contain any space (prohibited from entering) and must not exceed 64 characters.
The **Password** and email address used for the mailer cannot contain the following characters ;|`:<> / and space.

1. To launch the WindCube Scan software suite, select Windows **Start > All Programs > Leosphere > Wind Lidar Software**.

2. In the login window, set the system **IP Address**, user login and password.

> The following **IP Address** will always be accessible to the Lidar: **192.168.15.15.**

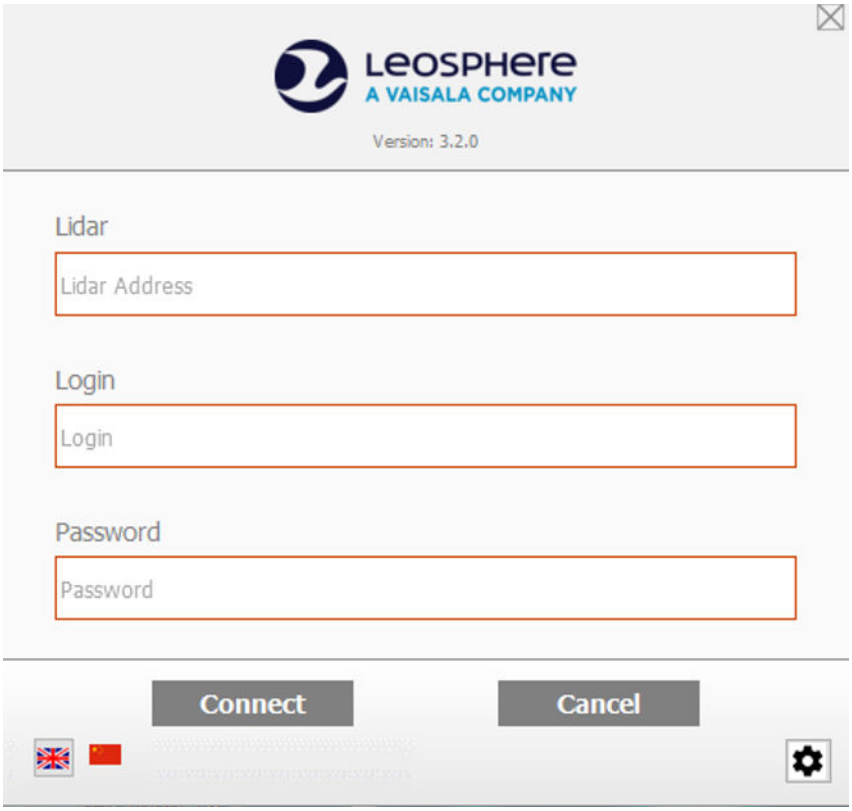


Figure 4 Login window

3. Enter your **Login** and **Password**.
4. Select the language by clicking on one a flag. If the language of your PC is not Chinese, then the default language will be English.
5. Then click on **Connect**.

When connection succeeds, user interface functionalities will be accessible.

> Most of the interface is translated but some data such as status or data files stay in english. Data files and the date formats are not translated nor the contents of the drop-down lists.

3.2 Configuring Port and Protocol

The configuration button on the bottom right of the connection panel allows you to configure the ports used by the client software to communicate with the server. For the moment only the port used by the **API** can be configured (**API** commands are used by several components of the GUI to communicate with the server).

For instance, if your laptop is communicating through internet by **HTTPS** `port 443`, these parameters should be indicated in the GUI settings since the **API** only listens to **HTTP** on `port 80`:

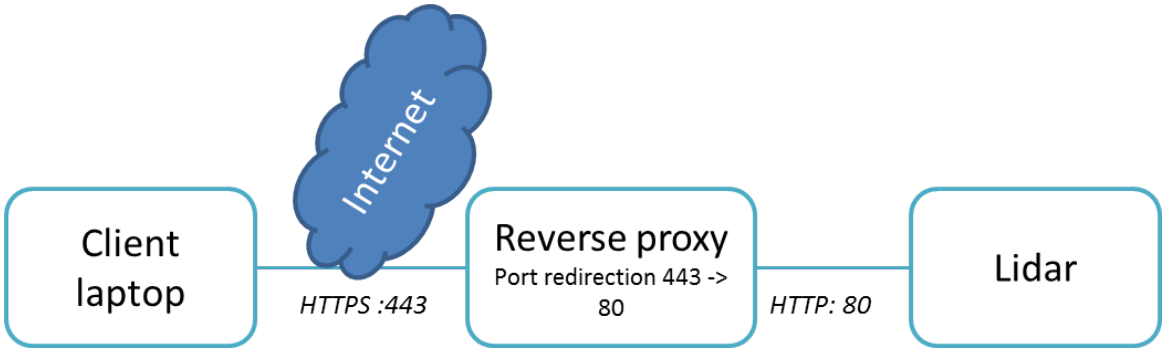
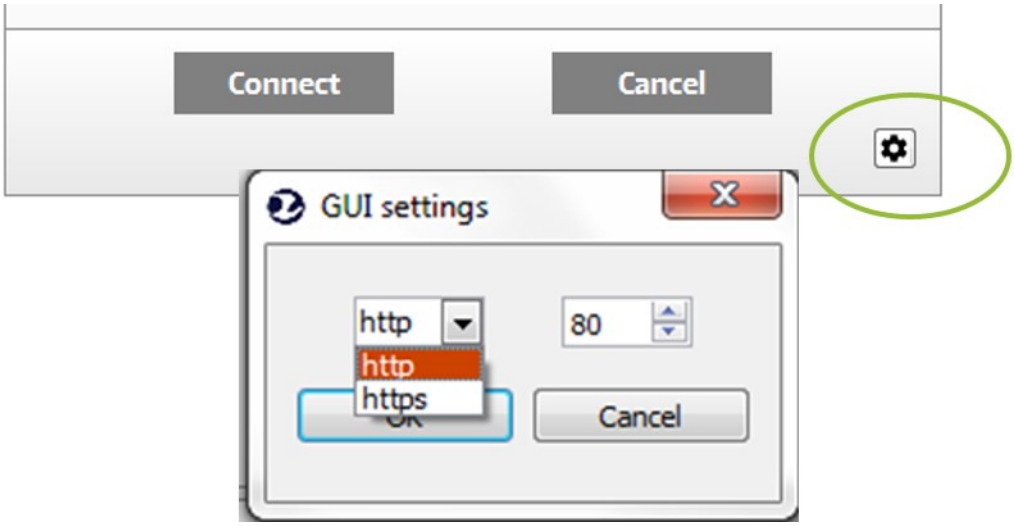


Figure 5 GUI Settings

1. To configure the port, click on the **SETTINGS** button.
   The **GUI Settings** window opens. By default, `http` protocol and port `80` are selected.



2. If needed, select the protocol (**`http`** or **`https`**). By default, the **`https`** port is **`443`**. Choose the port and click on **OK**. The new configuration is saved and taken into account for the next connection.

The following ports are used for other communications by the GUI: **`45001`**, **`45002`**, **`45003`**, **`45004`**, **`45005`**, **`5432`**. Therefore, if these ports are selected in the settings, the Lidar server will not be able to respond.

If the user clicks on **Cancel** the previous value is retrieved.

More information

- Leosphere API (page 156)

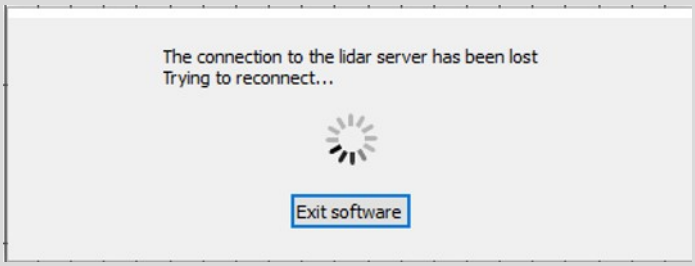
3.3 Connection problems

If there is a failed connection, two messages can be sent:

- `Client's connection refused`: **Login** or **Password** is unavailable.
- `Can't connect to the LIDAR`: TCP/IP connection is not operational.

1. In case of `Client's connection refused`, complete **Login** and **Password** correctly and try another connection.
2. In case of `Can't connect to the LIDAR`, check if the LIDAR **IP Address** is correct or if TCP/IP connection is working properly and try another connection.
3. Check also if the laptop is properly connected on the same network as the LIDAR.

When the connection to the system is interrupted, you will be warned by a pop-up in the current tab you are working in.



Clicking on **Exit software** button will close the software.
You can also wait for the return of the connection. In this case, the pop-up will disappear and the software will be accessible again, in the same state as before the loss of connection.

3.4 Overall interface description

3.4.1 Ergonomics

Once logged, the WindCube Scan Software suite graphical user interface is displayed.

By default, the **MEASUREMENT** tab is displayed.

The interface is divided into **4 main parts**.

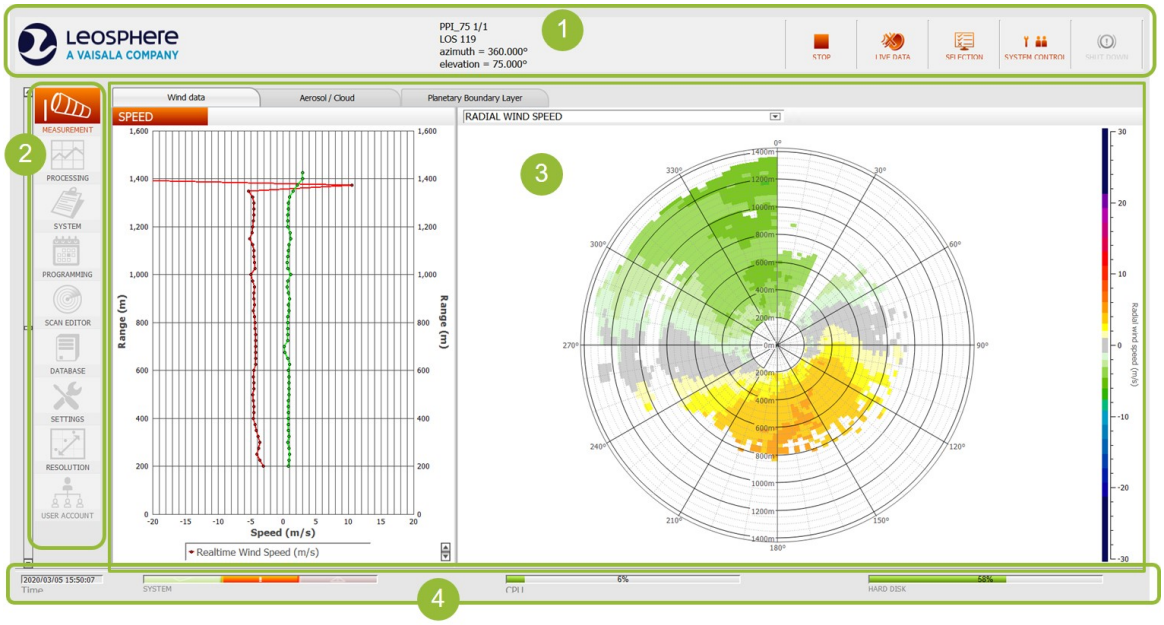
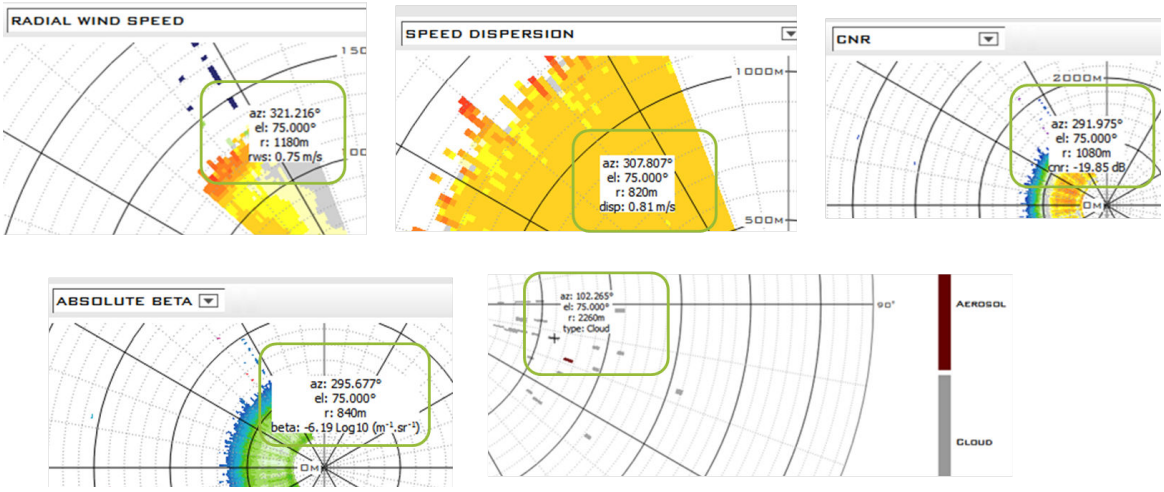


Figure 6 Interface description

1 The top toolbar and main action buttons (see details below).
2 The left part displays the menu and tabs.
Click on the tabs to access the various functionalities. Once a tab is selected, it turns into orange.
3 The central part. This part displays the main information, and allows the user to monitor, control the system, and create scans, depending on the selected tab.
4 The bottom bar (see details below).

In **MEASUREMENT** and **WIND DATA** or **AEROSOL/CLOUD** sub-tabs, tooltips appear in Polar graph (**PPI** and **RHI**), for **CNR**, RWS, dispersion, structures, relative and absolute beta, displaying range, azimuth, elevation.

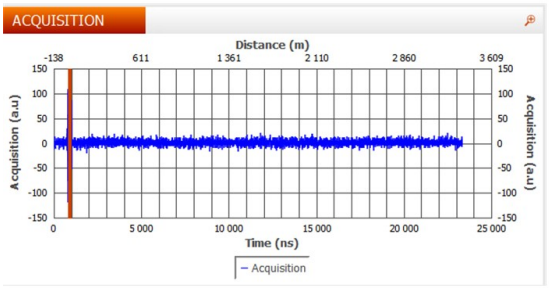
For structures, the terms **Cloud**, **Aerosol** or **NaN** are displayed.

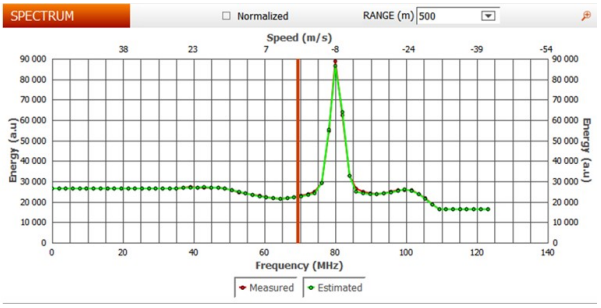


The displayed range is the theoretical one. For a **PPI** scan, the elevation will be fixed and the displayed azimuth will be the one which corresponds to the position of the cursor on the graph.

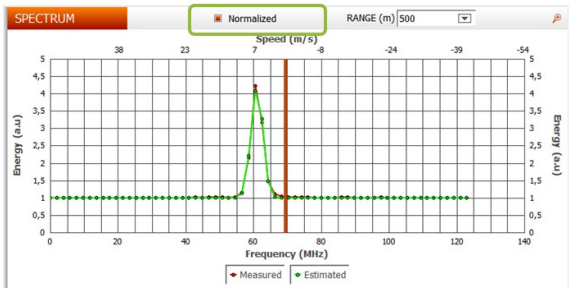
In **PROCESSING** tab, for spectrum and time signal graphs, an orange bar is displayed to indicate zero speed and 0 distance. This bar facilitates the system calibration and diagnostic. In case **Wind coming to the Lidar is negative** the negative speeds will be on the right and the positive speeds on the left of the bar. Conversely if you're in the positive convention.

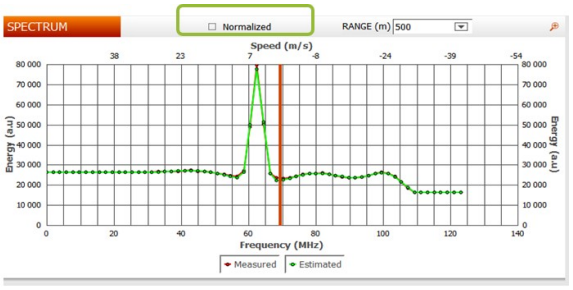
These bars are only visible from the expert profile.





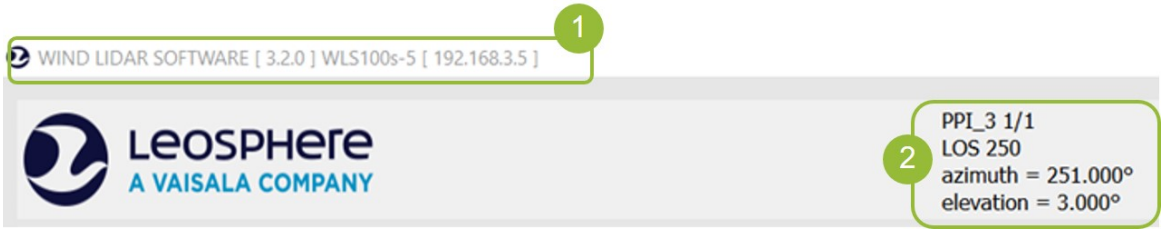
A checkbox, next to the range drop-down menu allows to normalize the spectra with respect to the noise spectrum.





3.4.2 The top toolbar

This top toolbar bar displays the version of the WindCube Scan software suite and the **IP Address** of the connected system.



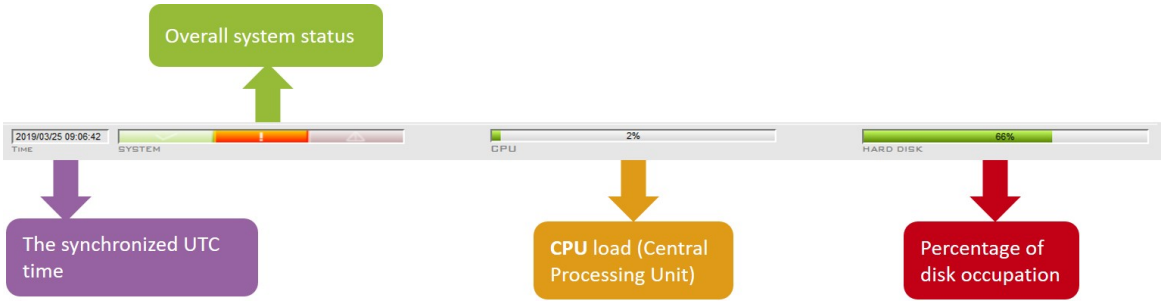
1 Software version, System serial Number and **IP Address**
2 Real time information about the running scenario (like scan name and current iteration)

You can close the window, on the right side of the screen.

3 Closing the window won't stop the measurements

3.4.3 The bottom bar

Overview of the bottom bar:



3.4.4 Main action buttons

Main action buttons in the top toolbar are described below:

Table 4 System control

	With **SYSTEM CONTROL** This button can be used to take control of a system. Only one user is allowed to take control at a time. As long as a user has the **SYSTEM CONTROL** he can keep it. Nobody can take it until he gives his hand or the inactivity time is up (5 minutes). **SYSTEM CONTROL** is needed to: • Start and stop the measurement • Make a programming • Submit a setting • Shutdown or restart the Lidar PC and server • Import a **resolution** for maintenance need
	Without **SYSTEM CONTROL** The user can't control the Lidar but can: • Edit and create scans • Edit settings • Monitor the Lidar • View an export data • Manage user accounts

Table 5 Live data and selection

	Data display inactive
	Data display active **LIVE DATA** button displays real-time data and status of the system the user is connected to. As long as the user has not clicked on **LIVE DATA**, real-time data are not displayed. When the user disabled **LIVE DATA**, the last measurement remains on the GUI.
	**SELECTION button** A popup opens; it allows selecting the data type to display (system status, **Radial Wind Speed**, wind speed reconstruction, **Spectrum**, acquisition, **CNR**, **Relative Beta** and structures). **SELECTION** button can be used to select the data to be retrieved from the system and displayed live to the GUI, saving communication bandwidth. To do so, tick the data types to be displayed in the pop-up window that opens when clicking to this button.

Table 6 Start/Stop

	**STOP button** Measurement is running; you can stop it. Each scan can be start/stop at any time.
	**START button** Measurement stopped, you can start it.

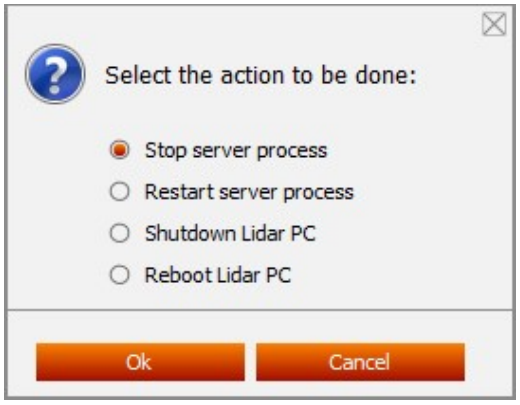
START	**START** / **STOP** acquisition button is inactive: • No system control: system control must be taken before being able to use **START** / **STOP** button. • Global status is critical: the general system status has to be OK or warning to be able to start the measurement.

Table 7 Shut down

SHUT DOWN	**SHUT DOWN** button is active It allows through a new window to select an action (stop server process, restart server process, shutdown Lidar PC, reboot Lidar PC. For more explanation, see below.
SHUT DOWN	**SHUT DOWN** button is inactive System control must be taken before being able to use **SHUT DOWN** button.

SHUT DOWN button leads to 4 actions:

- **Stop server process**: stop LIDAR server. It can be restarted only by using Monit (or the power supply switch as a last resort).
- **Restart server process**: restart the LIDAR server.
- **Shutdown Lidar PC**: stop LIDAR server and turns off the LIDAR computer. The LIDAR can only be restarted manually with the LIDAR power switch.
- **Reboot Lidar PC**: stop the LIDAR server and restart the LIDAR computer and server.



3.5 Exiting the WindCube Scan software

1. Click on the cross at the right top of the graphical user interface; a pop up window appears.

2. Click on **Yes** to confirm.

Exiting the software has no consequences on the LIDAR operation. The LIDAR remains operational.

4. Configure and program the Lidar

4.1 Programming principle

Programming the Lidar involves 3 tabs: **SETTINGS**, **SCAN EDITOR** and finally **PROGRAMMING** tabs.

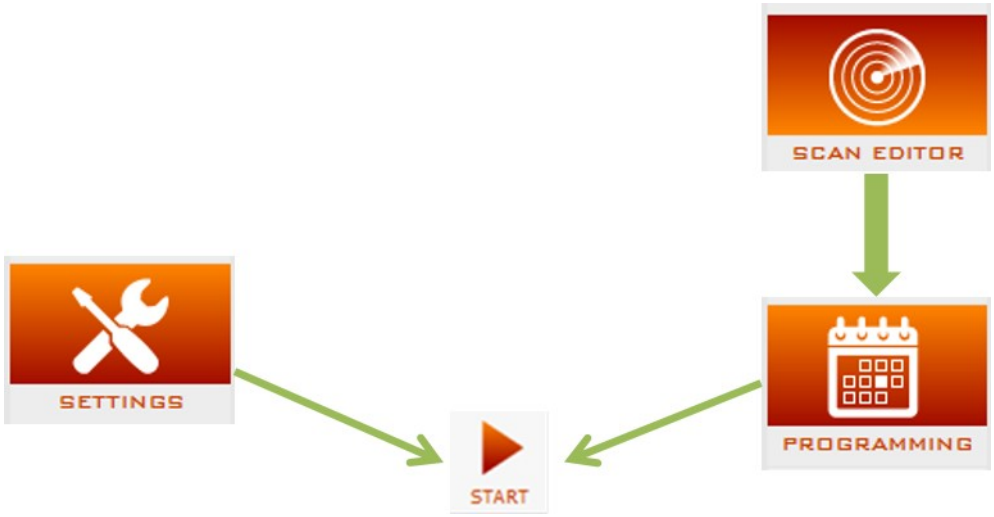
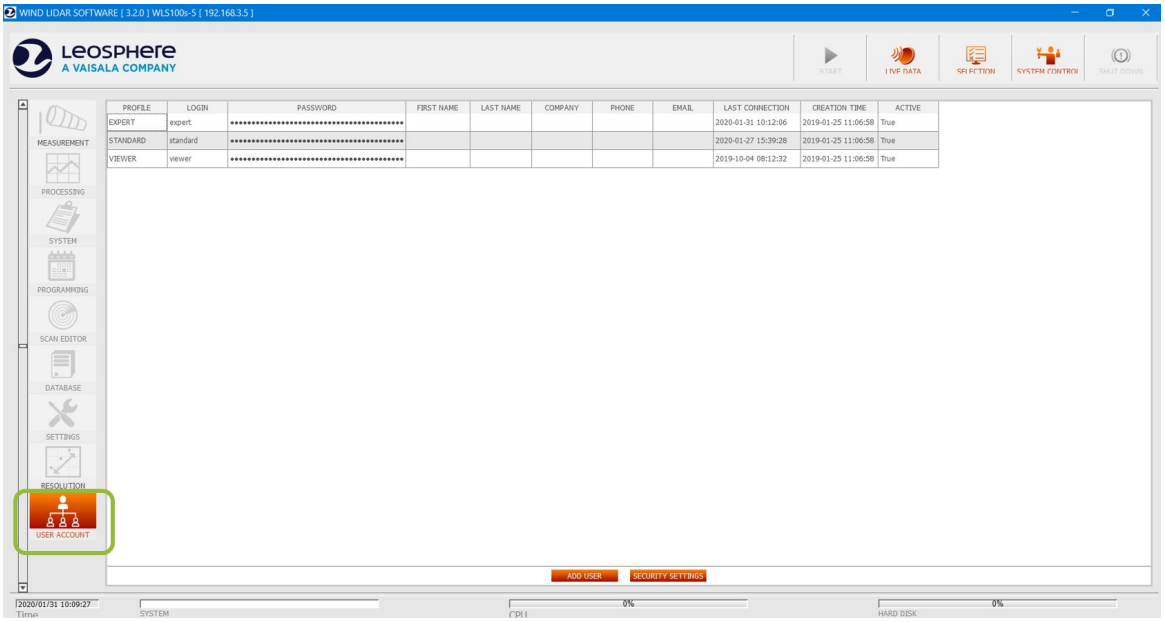


Figure 7 Programming principle

- **SETTINGS** tab: general system configuration
- **SCAN EDITOR** tab: scans configuration (**PPI**, **RHI**, **DBS** etc.)
- **PROGRAMMING** tab: system programming using scans created in **SCAN EDITOR** tab.

4.2 User account tab



Three levels of users are defined: Viewer, Standard and Expert. The rights given to each user type are described in this table:

Table 8 User rights

Given rights	Viewer	Standard	Expert
Observe live data	✓	✓	✓
Observe the general system status	✓	✓	✓
Observe the subcomponent status	✓	✓	✓
Program scans	✗	✓	✓
Modify parameters that directly impact the measurement quality	✗	✗	✓
Modify parameters that directly impact the system status	✗	✗	✓
Modify other parameters	✗	✓	✓
Start/Stop the measurement or the system	✗	✓	✓
Download data	✗	✓	✓
Delete data	✗	✗	✓
Import and export resolutions	✗	✗	✓

Expert user can manage accounts in **USER ACCOUNT** tab.

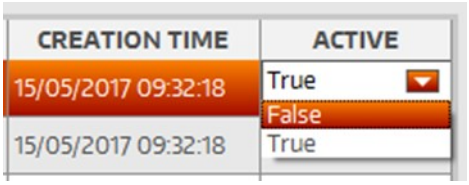
Expert user can:

- Add new user profile (by clicking on **ADD USER**);
- Modify profile;
- Modify login and password;
- Modify data such as user's first name, last name, company, phone number and email;
- Activate/Deactivate user accounts.

4.2.1 Modifying user account

If you need to activate or deactivate a user account:

1. Double-click on the **ACTIVE** cell to activate (on **True**) or deactivate (on **False**).



2. For any other modification, double-click on any cell and change its value.

CAUTION! There is no double check in case of password change. Make sure to write it correctly.

- It is not possible to erase a user profile from the user account list but you can deactivate it (last column of account parameters).
- There are no limits on the number of users able to connect simultaneously. However, if more than 3 users are connected at the same time, there might be a slowdown of the software.

4.2.2 Securing your user account

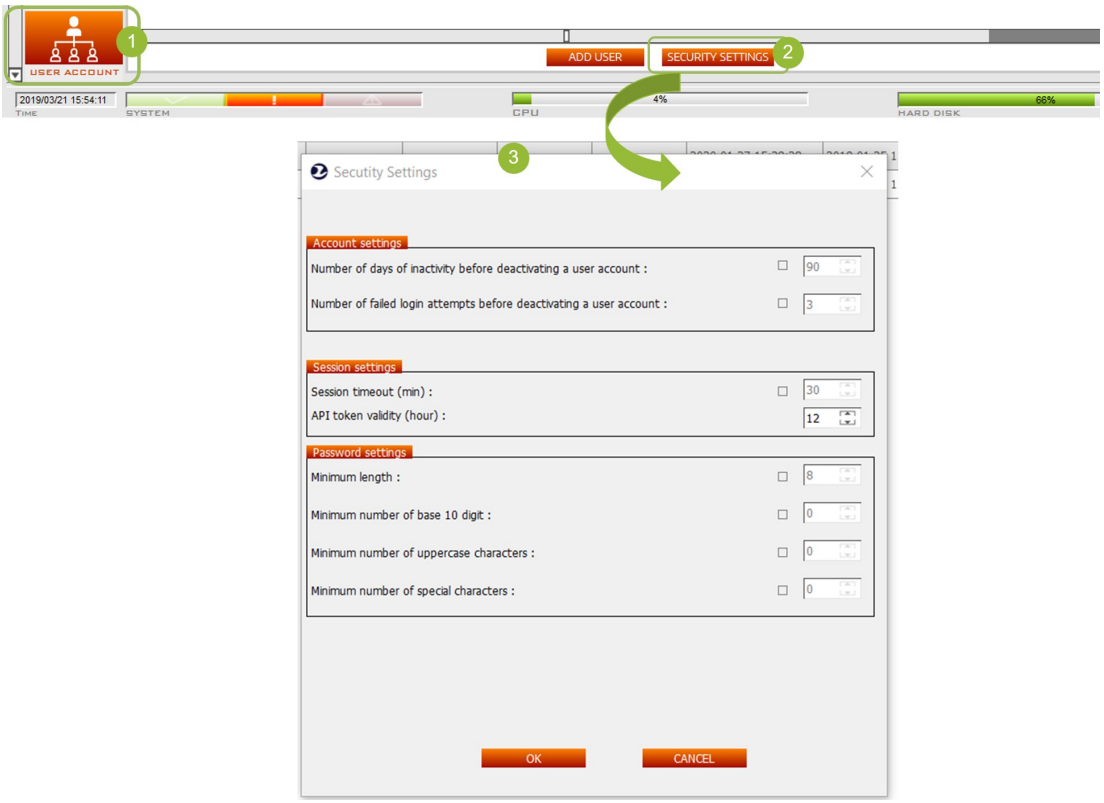
These settings are available only for expert profile.

The user can set up:

- The account settings
- The session settings (session timeout and setting of the token validity)
- The password settings

Each element can be selected or disabled via a checkbox preceding the field.

1. Go to **USER ACCOUNT** tab.
2. Click on **SECURITY SETTINGS** button.
   The **SECURITY SETTINGS** pop-up opens.

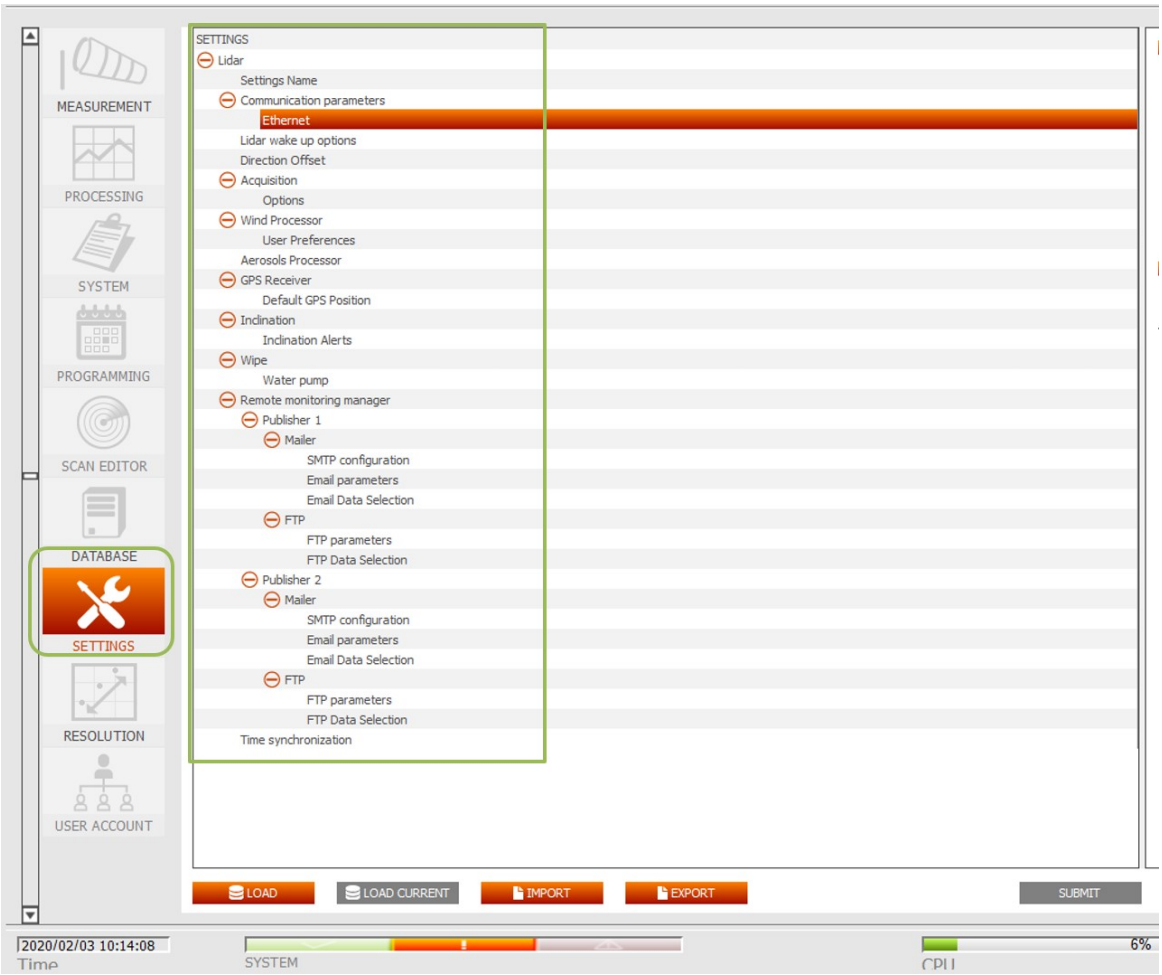


In **Session settings** section you can set the **API** token validity.
This value is between 1 hour and 24 hours. By default, it is set on 24 hours.
If this value is changed, a message will display indicating that the software needs to be restarted. The **API** will also be restarted.

- In case of incorrect password, an error message is displayed indicating the number of attempts remaining before disabling the account.
- In case of modification of an account, if the entered **Password** is not compatible with the configured mask, an error message is displayed and the previous **Password** will be kept.
- If the maximum number of attempts is reached or the account has expired, a message indicates that the account is locked.
- If your account is locked, another expert account owner shall reactivate it (last column of account parameters).

4.3 Settings tab

The **SETTINGS** tab allows configuring your system. This tab is accessible for standard and expert profiles. By clicking on the **SETTINGS** tab, the settings tree displays on the left part.



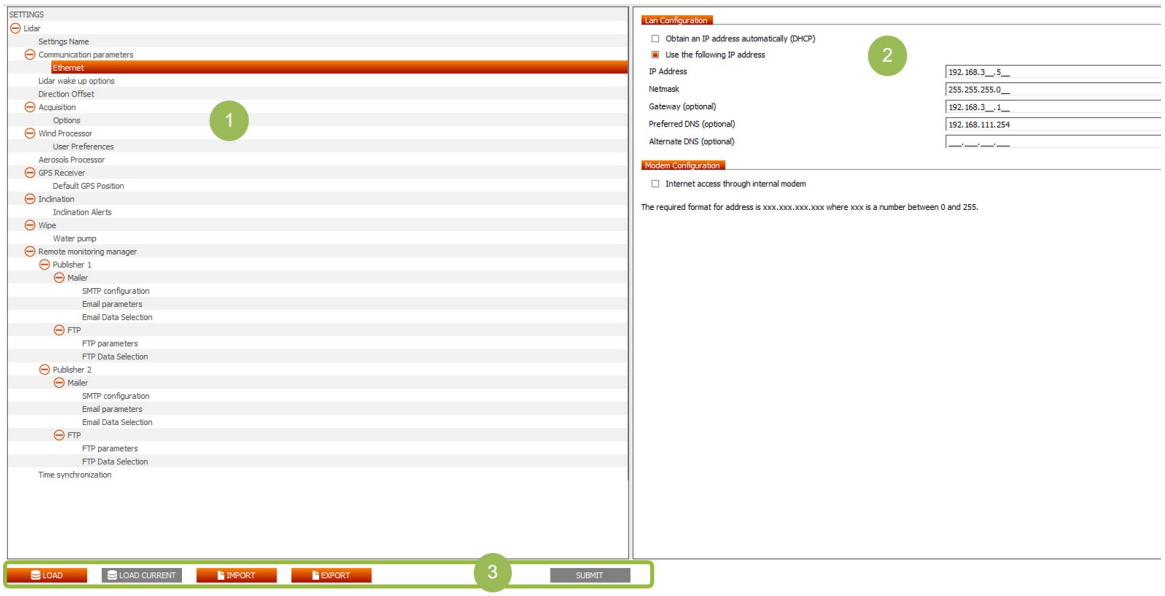


Figure 8 Settings window

1 Configuration tree
2 Setting screen
3 Actions buttons

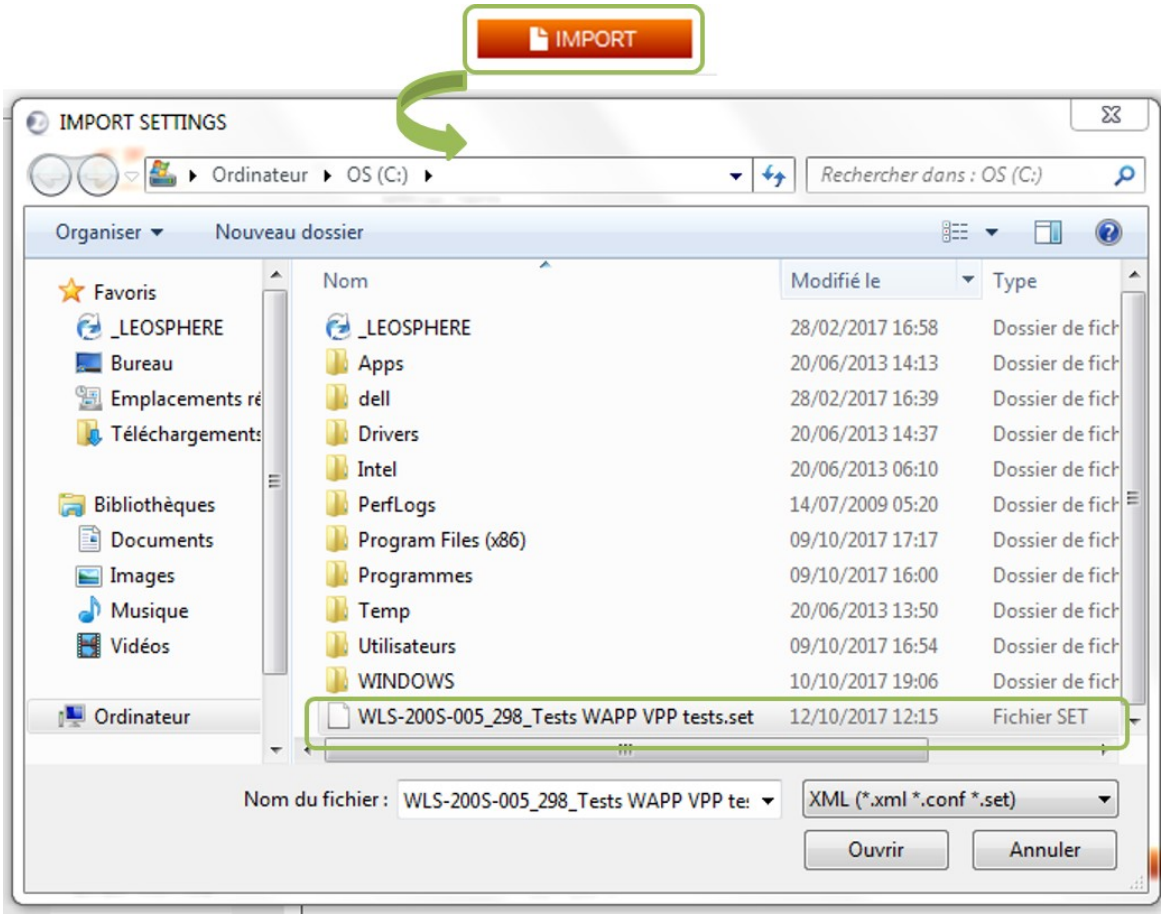
Table 9 Settings tab's actions buttons

Button	Description
LOAD	Load a setting from the settings library.
LOAD CURRENT	Load and visualize the setting currently applied to the system. The button is active as soon as the setting displayed differs from the one applied to the system.
IMPORT	Import and visualize a setting stored on your computer.
EXPORT	Export a setting to your computer.
SUBMIT	Apply the current setting to the system. This button is activated only when the user has the system control. The button is active only if the setting displayed differs from the one applied to the system.

4.3.1 Importing a setting

The [Import] button allows to import and to visualize system settings.

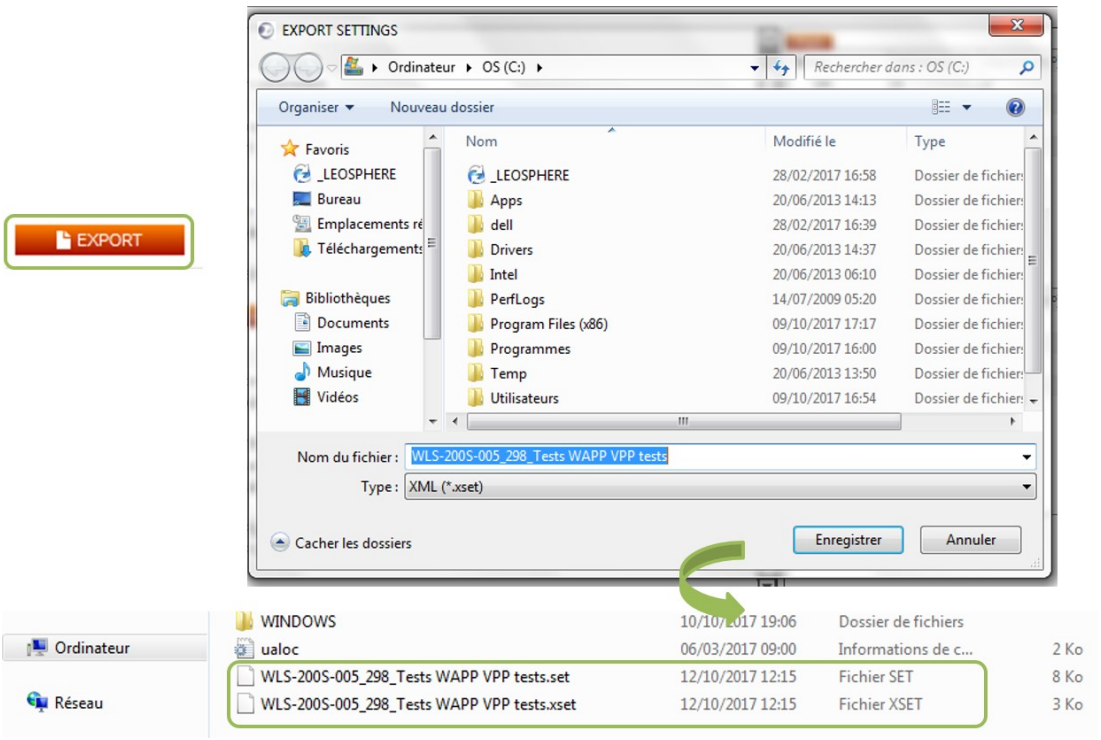
1. Click on **IMPORT** button. The **IMPORT SETTINGS** window opens.
2. Select a file.
3. Click on **Open**.



4.3.2 Exporting a setting

1. Click on **EXPORT**. The **EXPORT SETTINGS** window opens. The File name and Type appear.

2. Click on **Save**.Two files are created when you export a setting.



For further information on the settings file format, please refer to :

More information

- Scan, settings and resolutions files (page 154)

4.3.3 Creating or modifying a setting

To create or modify a setting:

1. Take the **SYSTEM CONTROL**.
2. Select the item you want to configure in the configuration tree. On the right, the corresponding settings parameters appear.
3. Set the parameter you need.

4. Click on the **SUBMIT** button.The setting is created in base under a new ID and applied to the system.

- All information is stored in memory at each change of section.
- To apply all settings to the Lidar, click on **SUBMIT**. In that case a new setting is added in the database.

CAUTION! It is not possible to delete a setting from the database.

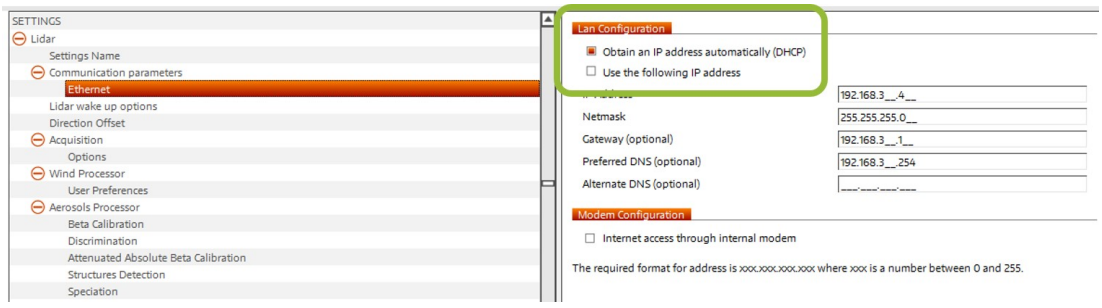
4.3.4 Settings name

1. Click on **Settings Name**.
2. Write the name of the current settings.
3. Click on **SUBMIT** button.

4.3.5 Changing the network parameters

If absolutely necessary, it's possible to change the network parameters, to do so:

1. Select **Communication parameters > Ethernet**.
2. Tick **Obtain an IP address automatically (DHCP)**.



3. In case you tick **Use the following IP address**.

4. Fill in the parameters to be applied.
   - Some parameters are optional (**Gateway**, **Preferred/Alternate DNS**). When the settings are changed and are different from the previous saved settings (the ones by default) a pop-up appears indicating the computer will restart if the settings are accepted.
   - If you click on **REBOOT** the settings are saved, the network settings are applied to the PC and the PC restarts. So, you also have to restart the GUI.
   - **Modem Configuration** should not be used. This option is not available for the moment.

CAUTION! If you are configuring your system in DHCP, make sure you are able to recover the **IP Address** that has been assigned to the Lidar by YOUR network.
Never use the following addresses:
- all with : `192.6.94.X`
- and `192.168.15.15`

4.3.6 Activating the Autorun function

If you activate the **Autorun**, all measurements will start automatically when the Lidar starts.

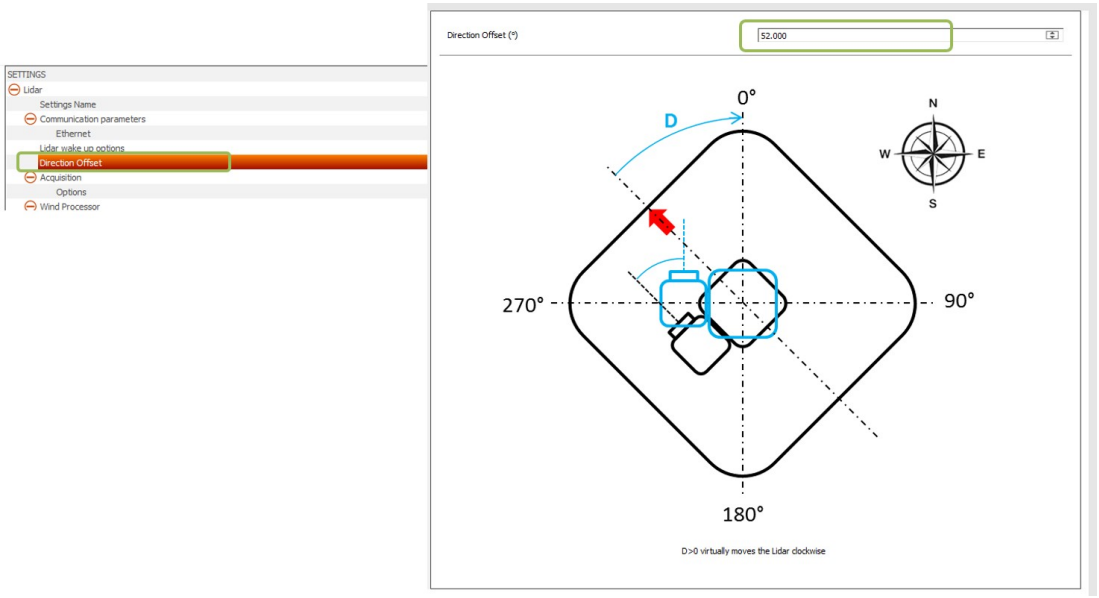
1. Select **Lidar wake up option**.
2. Tick or untick the **Autorun**.

4.3.7 Applying a direction offset to the scanner head

This feature allows you to set an offset to the scanner. You will have to enter an offset in azimuth in case it is not possible to align the Lidar to the North.

1. Select **Direction offset**.

2. Change, if needed, the **Direction offset**.
   The **Direction offset** will be applied on the scanner head that will take a new zero azimuth angle.



4.3.8 Activating the spectrum data recording (optional)

This feature allows you to save the **Spectrum** in the database. To avoid having all the **Spectrum** recorded you can choose between 3 radio buttons: **All**/**Noise only**/ **None**. By default, **None** is checked.

All: records all spectra

Noise only: records only the noise spectrum

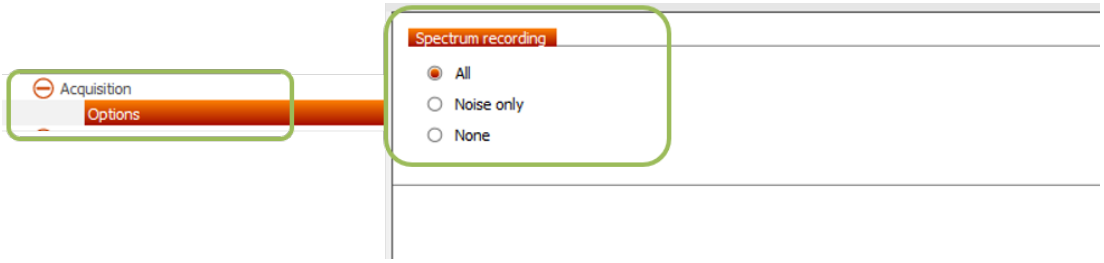
None: records nothing

CAUTION!

- Beware, **Spectrum** data uses a lot of disk space. For this reason, we recommend checking **None** in order to avoid loading the database unnecessarily.

1. Select **Acquisition > Options**.

2. Tick **All** if you want to save all the spectra in the database.



4.3.9 Selecting the wind convention

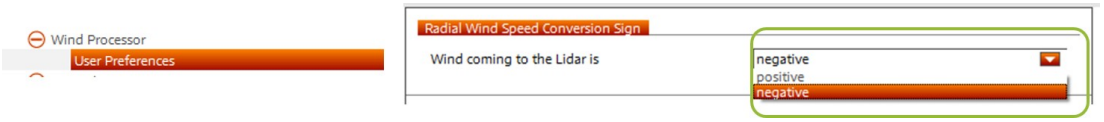
This setting can only be changed by an expert profile.

This feature allows the user to choose his convention (**negative**/**positive**).

CAUTION! We recommend choosing one convention at first use and then never change it.

- **Radial Wind Speed** sign and color convention configured in factory is: **Wind coming to the Lidar is negative**.

1. Select **Wind Processor > User Preferences**.
2. Select, using the dropdown menu, if the wind coming to the Lidar is **negative** or **positive**.



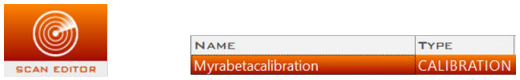
- Whichever this convention, red color always represents a **positive** value, blue color a **negative** value. The color convention cannot be changed.
- Changing the sign convention does not affect **DBS** files.

4.3.10 Setting beta calibration (optional)

Calibration should be performed at every new installation site and after every focus adjustment. It is advised to perform the **Calibration** manually (not programmed in the **SCHEDULER** tab) when the weather conditions are appropriate (clear air conditions and no rain, no clouds, no obstacles). Once the **Calibration** is done, it is taken into account in the other scans (**PPI**, **RHI**, **DBS**, **LOS**). **Beta calibration** is subject to strict scenario configuration restrictions.

Scan configuration

Calibration consists of a very specific **PPI** scan named “Myrabetacalibration” in the **SCAN EDITOR**, in this scenario the accumulation time is fixed at 1s.

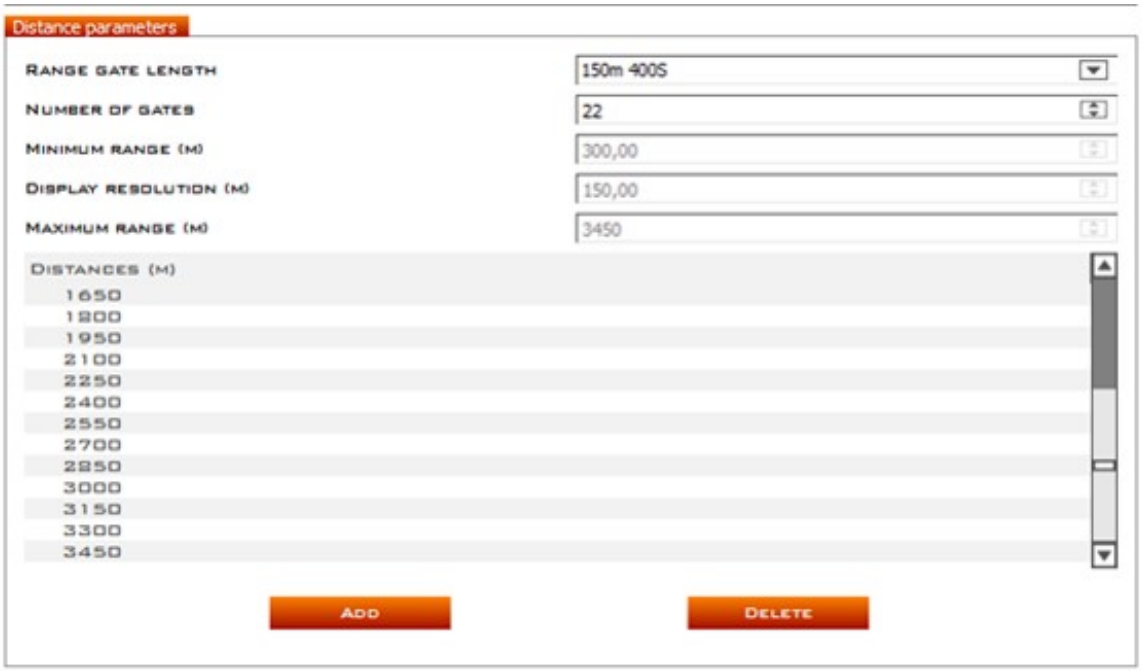


Angular parameters must be chosen in such a way that there are no obstacles along the **LOS** during the **Calibration**. This specific **PPI** has to be configured as follows:

- **elevation angle** should be lower than 5° to preserve the atmospheric homogeneity hypothesis. If this configuration is not possible in a particular site, a higher elevation angle could be considered but the higher the **elevation angle** is, the less accurate the **Calibration** will be.
- Make sure to have a clear view, it is recommended to configure an **azimuth angle** of at least 45°. If this configuration is not possible in a particular site, a smaller azimuth range could be considered but the **Calibration** will be less accurate.
- A smaller azimuth range with less than 5° **elevation angle** is preferable than a wider azimuth range with higher **elevation angle**, since atmosphere homogeneity is easier to reach at lower elevation.

Required elements for a beta calibration

- Disjointed gates are not allowed and accumulation time should be set at 1s.
- Gates must have the size of the spatial resolution, so the **DISPLAY RESOLUTION** has been fixed at ‘range_gate_length’ and it is not possible to modify the gate distances manually.
- The **MINIMUM RANGE** is set to 2 *`range_gate_length`.



The following scenario must be configured:

Table 10 Scenario configuration for Beta calibration

Parameters	Windcube 100S-200S	Windcube 400S
Angular resolution (°)	1	1
Range gate length (m)	50	75
Number of gates	37 (1900m of maximum range)	25 (1950m of maximum range)
Minimum range (m)	100	150
Display resolution (m)	50	75

Checking calibration achievement and configuration conditions

For the fitting algorithm to work, some conditions have to be respected:

- There shall not be any structures along the **LOS**.
- The **CNR** difference between two consecutive gates all along the **LOS** shall not exceed 5dB (in other words, no obstacle is detected).
- The **Radial Wind Speed** data in the filtering area must have a status = 1 (accepted data).

If one of these conditions is not respected, the instrumental function is not calculated and therefore not registered in the database.

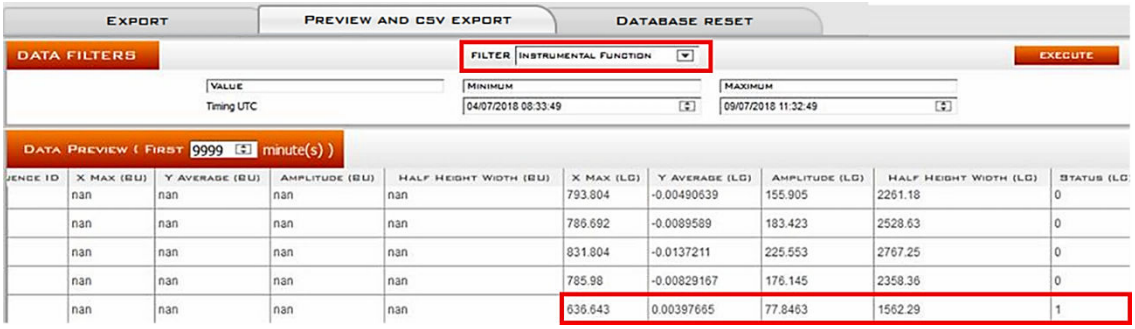
Table 11 Configuration conditions

Lorentz distribution parameters	Limits	Default value
Default Y0	[0 ; 0.1]	0.0027
Default A	[0 ; 6000]	80
Default W	[100 ; 25000]	1545.0
Default X0 (m)	[300 ; 15000]	484.5

Fitting function confidence index

If the **Calibration** succeeded (status=1), the fitting parameters are saved until modifications on the settings or reboot of the Lidar server.

You can see the status from **DATABASE** tab, in **Preview** sub-tab and instrumental function filter or in the export of the **Relative Beta** scan.

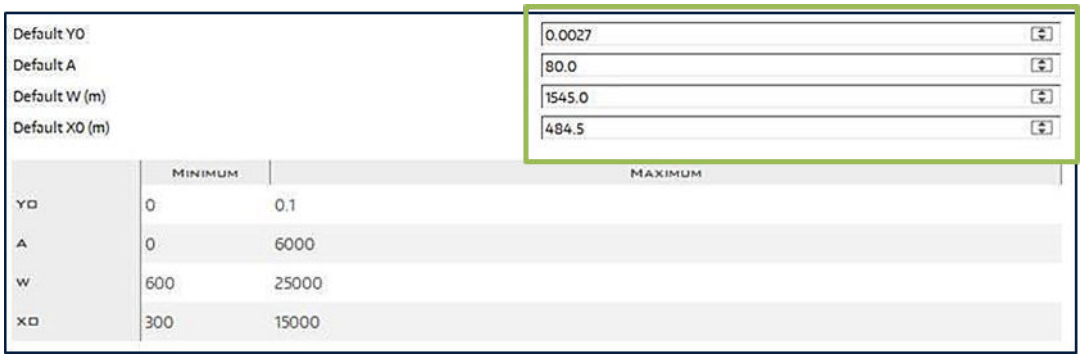


ENCE ID	X MAX (BU)	Y AVERAGE (BU)	AMPLITUDE (BU)	HALF HEIGHT WIDTH (BU)	X MAX (LC)	Y AVERAGE (LC)	AMPLITUDE (LC)	HALF HEIGHT WIDTH (LC)	STATUS (LC
	nan	nan	nan	nan	793.804	-0.00490639	155.905	2261.18	0
	nan	nan	nan	nan	786.692	-0.0089589	183.423	2528.63	0
	nan	nan	nan	nan	831.804	-0.0137211	225.553	2767.25	0
	nan	nan	nan	nan	785.98	-0.00829167	176.145	2358.36	0
	nan	nan	nan	nan	636.643	0.00397665	77.8463	1562.29	1

It is advised to set a maximum time in UTC ahead of the present time to make sure that no current measurement is missed. “Execute” should be done regularly to refresh the results.

If the **Calibration** does not succeed (status=0), the default parameters defined in **SETTINGS** are used. It is necessary to change the previous settings with the parameters extracted from the last successful **Calibration**. In this case, the correct parameters will be taken into account if the Lidar server reboots.

Parameters displayed in **Preview and CSV export** with status = 1 have to be filled in the aera indicated by the green box:



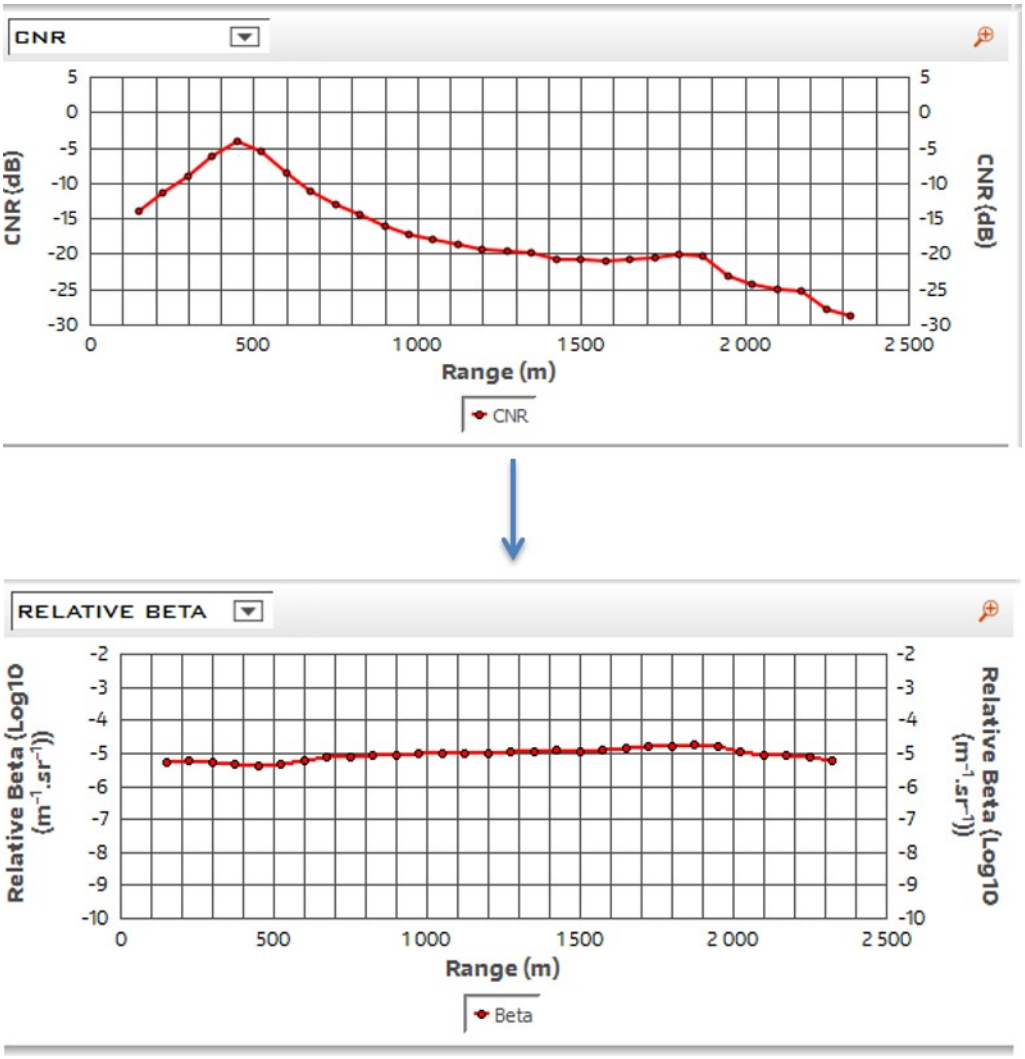
Parameter name mapping between **DATABASE** and **SETTINGS** tabs is as follow:

DATABASE	SETTINGS
X MAX (LC)	Default X0
Y AVERAGE (LC)	Default Y0
AMPLITUDE (LC)	Default A

HALF HEIGHT WIDTH (LC)	Default W

Calibration display

To confirm that the **Calibration** has been performed properly (status=1), a **PPI** scan with the angular values used during **Calibration** scan may be played. The **Relative Beta** curve has to be flat on the focalization area where the **CNR** increases in the firsts ranges



4.3.11 Attenuated absolute beta calculation (optional)

The absolute attenuated backscatter coefficient is a research function that has to be calibrated with an external instrument such as a sun photometer. Through the **Calibration**, the offset induced by the instrumental constant can be defined.

4.3.12 Aerosol and cloud detection and discrimination (optional)

The default parameters of this function are in the settings tab, do not change them.

4.3.13 Setting the PBL detection (optional)

The default parameters of this function are in the settings tab, do not change them.

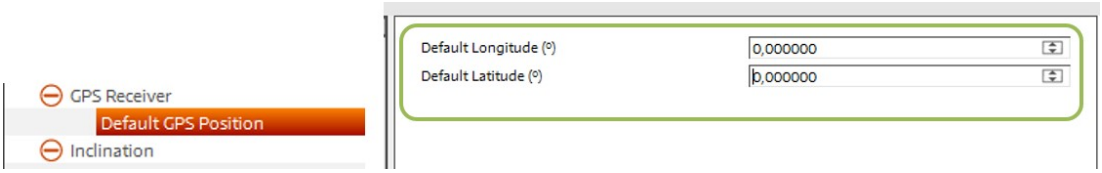
4.3.14 Setting the default GPS position

These settings are available only for expert profile.

Default **GPS** position is used at first start for the **PBL** option.

When the **GPS** has received a valid signal once, this measured value is used instead.

1. Select **GPS Receiver > Default GPS Position**
2. Change, if necessary, the **Default Longitude** and **Default Latitude**.



4.3.15 Setting the inclination alerts

This feature allows you to modify inclination alert values (**Pitch** and **Roll**).

We recommend letting the default parameters.

1. Select **Inclination** → **Inclination Alerts**.

2. You can change the value of the alert either of **Pitch** or **Roll**.

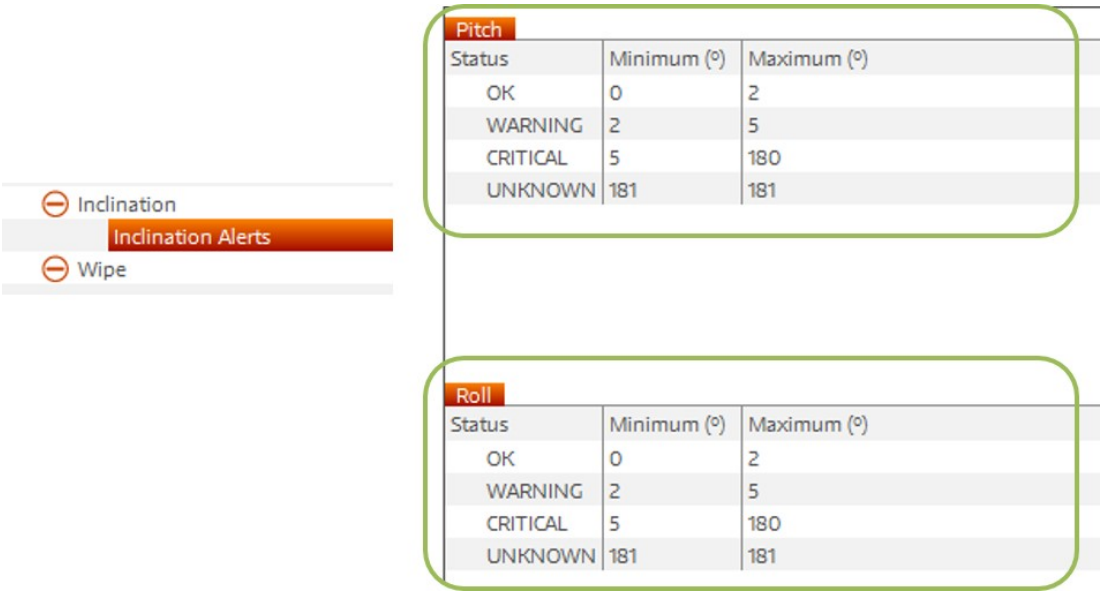


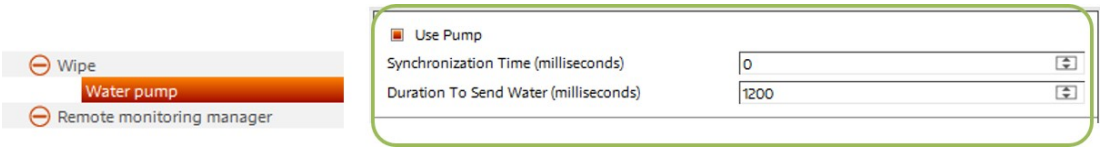
Figure 9 Pitch and Roll setting

4.3.16 Setting wipe settings

This feature allows you to program when and how the water is sprayed.

We recommend letting the default parameters.

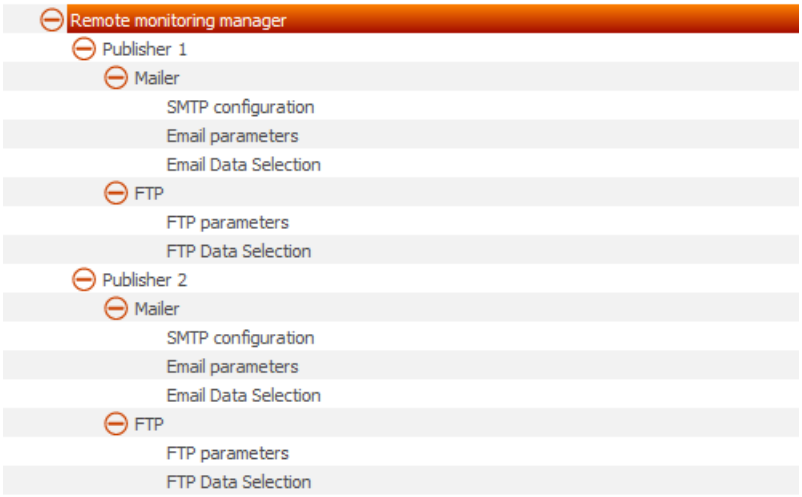
1. Select **Wipe** → **Water pump**.
2. Check the box **Use Pump** if you want to use the pump.
3. Set the **Synchronization Time** and the **Duration To Send Water**.



4.3.17 Activating email alerts and FTP export

To activate the mailer and **FTP** functions refer to the steps described in the following paragraphs:

1. Select **Remote monitoring manager**.



4.3.18 Setting the mailer

The **Mailer** feature requires you to parameter **SMTP configuration**, **Email parameters** and **Email Data Selection**.

You can choose to receive email and also in what kind of situation (status, activities).

SMTP configuration

To configure the **Mailer**:

1. Select **Remote monitoring manager > Publisher 1 > Mailer > SMTP configuration**.
2. Fill in all fields: **Server**, **Port**, **User** and a **Password**.

Figure 10 SMTP configuration

For the **Password** and other fields the following characters cannot be used **|':>&** and you cannot enter any space.

Email parameters

You can now activate the mailers by ticking **Activate device** in **Email parameters** fields.

3. Select **Remote monitoring manager > Publisher 1 > Mailer > Email parameters**.
4. Tick **Activate device** checkbox.
5. Fill in all fields: **sender**, **recipients**, **recipients in copy**: **Cc** (optional) and recipients in hidden copy: **BCC** (optional).

Email data selection

6. Select **Remote monitoring manager > Customer Publisher > Mailer > Email Data Selection**.
7. Select, by checking boxes, **actions triggers**.

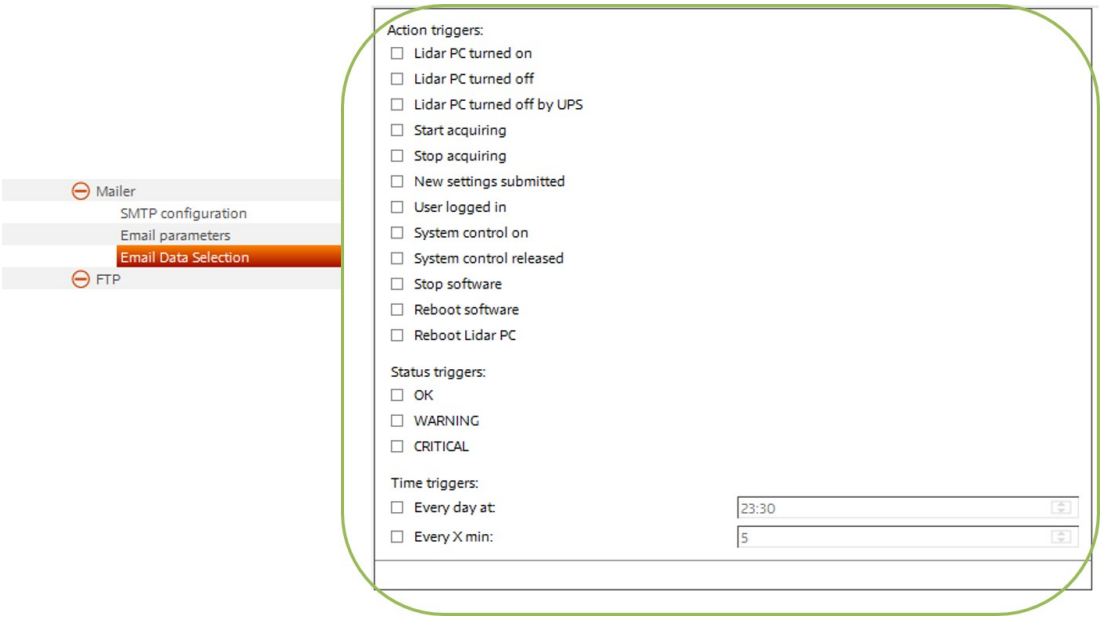


Figure 11 Actions triggers

From this window, you can select different triggers for the sending of an email. It's possible to select various triggers at the same time. In this case, you will receive a large amount of email.

- The email sending period, in case of a periodic trigger, is reset at each new submitted setting.
- In case of a sending "every X min", the first email will be sent no more than 1 minute after the fixed period. The following will be sent periodically.

```
Exemple of a sent email
System serial number: WLS200S-5
Event: Stop acquiring
Timestamp: 2018-09-24 04:46:57 PM
User: adminLidar status - WARNING - 60 - LIDAR STATE: STOPPED
Detailed status:
FTP Supplier - UNKNOWN - 5 - Device not activated.
Inclination - WARNING - 4 - Waiting for communication.
Inclinometer - CRITICAL - 4 - Waiting for communication.
PTU Sensor - CRITICAL - 14 - Waiting for communication.
Water Pump - WARNING - 5 - Device not activated.
This is an automatic email. Please don't reply.
```

Devices with an **OK** status are not displayed.

The logged events in emails are the following:

Table 12 Logged events in emails

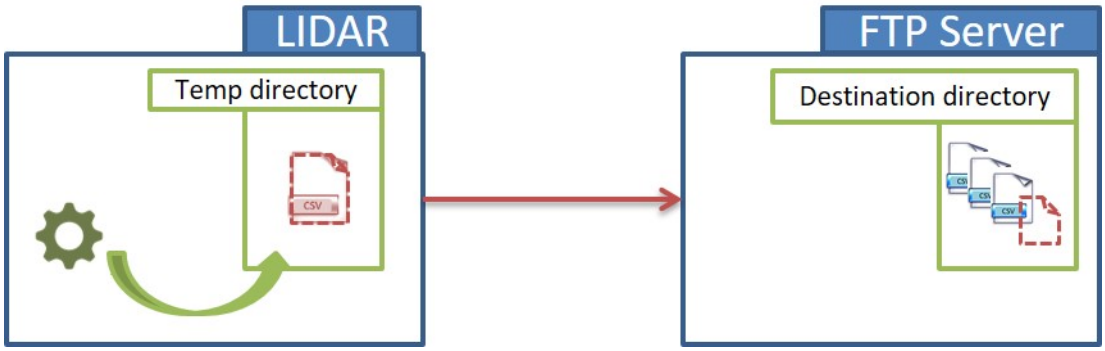
ACTION/TRIGGER	EVENT IN THE EMAIL
PC switch ON	Boot Lidar PC
PC switch OFF by the GUI	Shutdown Lidar PC
PC reboot from the GUI	Reboot Lidar PC
Transition to UPS	UPS PC shutdown
Start acquisition (automatic or manual)	Start acquiring
Stop acquisition (automatic or manual)	Stop acquiring
New settings submitted to the system	New settings
User connection on the GUI	User logged in
Start system control	Start operating
Stop system control	Stop operating
Stop of the process by the GUI	Stop server process
Reboot of the process by the GUI	Reboot server process
Switch to status : OK /warning or Critical	Status passed to OK/WARNING/CRITICAL
Send every day at a special time	Scheduled email
Send every X minute(s)	Scheduled email

4.3.19 Configuring the FTP

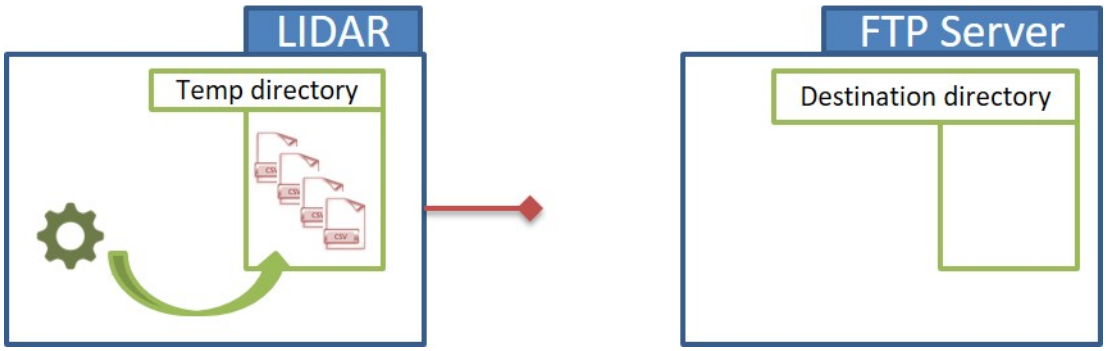
For this step you need to configure a **FTP** server before, on the same network than the LIDAR. **FileZilla server** is approved and recommended.

User can manage automatic data sending to a server thanks to **FTP** (**F**ile **T**ransfer **P**rotocol).

When **FTP** server is enabled, the files to be sent to the server are created in a temp directory, inside the Lidar. If the Lidar is connected to the **FTP** server, these files are immediately sent:



In case of bad configuration of your **FTP** server or a bad communication between the Lidar and your **FTP** server, automatic file sending will be stopped and data accumulate in temp directory:



CAUTION! Make sure there are no whitespace characters in the **FTP** server address. A bad configuration of your **FTP** server or a bad communication between the Lidar and your **FTP** server can stop the automatic file sending.
If the **FTP** is incorrectly configured or if the link is broken, the temporary directory will fill up and the **FTP** status will turn to Warning.

To parameter the **FTP** feature:

1. Select **FTP > FTP Parameters**.

2. Select **Activate device** to activate **FTP** transfer. **Status update period** is the refresh period of the **FTP** status. It's recommended to keep it at 5000ms.
3. Set the **Server**, **Port**, **User** and **Password** fields of the configured **FTP** server.

> For the password and other fields the following characters cannot be used **|':>&** and you cannot enter any space.

4. Tick the box(es) to choose file format and **FTP** type.

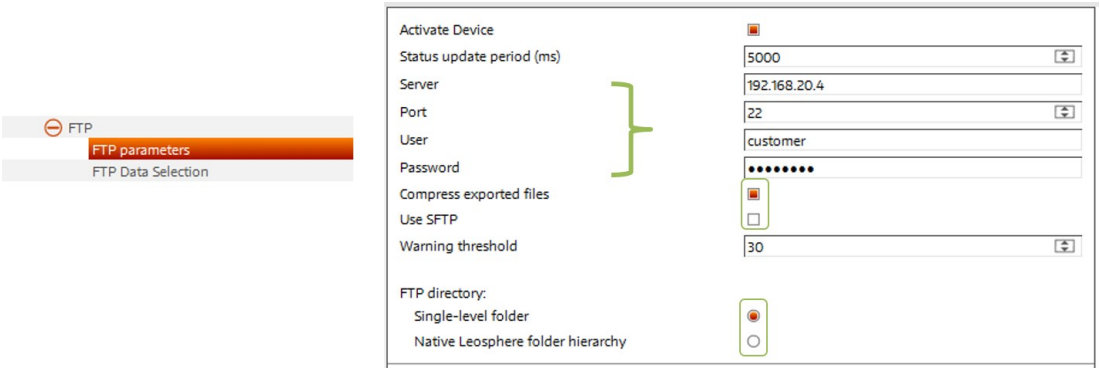
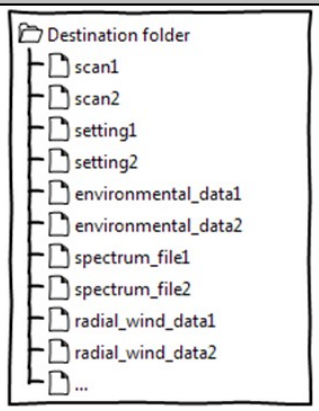
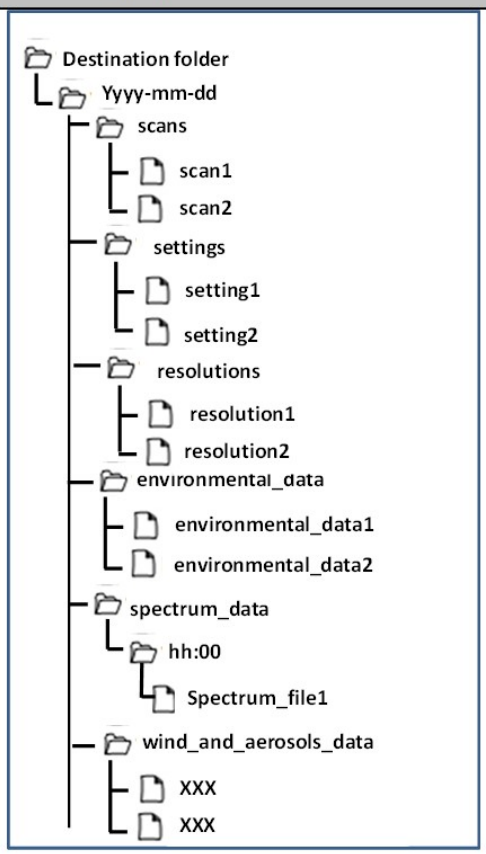


Figure 12 FTP parameters

5. Set the **Warning threshold**. **Warning threshold** field corresponds to the number of files contained in the **FTP** temp directory, from which the **FTP** status turns into Warning.

6. Choose the files organization of the FTP directory: **Single-level folder** or **Native Leosphere folder hierarchy**:

If you select "single-level folder" all files will be sent to a unique directory.	If you select "Native Leosphere folder hierarchy" the files will be sent with the following organization
	

- Be careful to disable **Activate device** to avoid files generation in case of connection problems with the **FTP** server.
- It's recommended to confirm good **FTP** connection by checking the content of the destination folder.
- It's recommended to export compressed files (gzip format) to save bandwidth and server space.

4.3.19.1 Configuring SFTP by a certificate

It is possible to configure the sftp by a certificate. To do so, go to **SETTINGS** tab and **FTP Parameters**. If **Use SFTP** is checked, the checkbox **Use certificate** displays. If **Use certificate** is checked a field with a public key appears.

This key is generated by the Lidar. It must be communicated to the ftp server, installed by the client. The certificate is generated at the Lidarserver start.

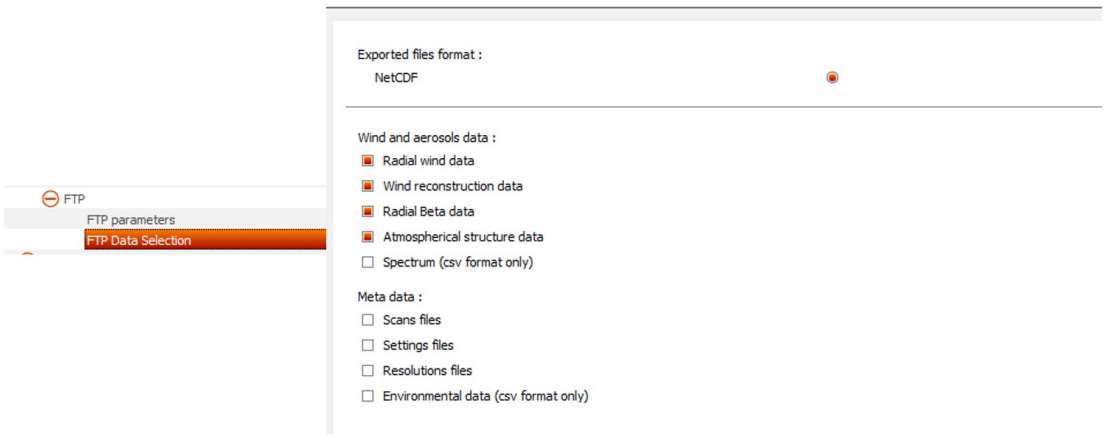
In case **Use certificate** is checked, the **Password** field is greyed out and you don't need to use it. In other cases, it's always possible to reach the server using the **User** and **Password** fields.

4.3.19.2 Selecting data to export to the FTP server

For selecting data to export to the **FTP** server

1. Select **FTP > FTP Data Selection**.
2. Select the exported file format (**NetCDF**) and data type (Wind and aerosol data or meta data).

3. Click on **EXPORT** button.



The **NetCDF** file format gathers all types of data (radial, reconstruction, beta, structure, meta data ...) into a single file and statuses indicate if the data is usable or not. The data in the **NetCDF** files is non-filtered. For more details about **NetCDF** format, refer to NetCDF file format (page 128).

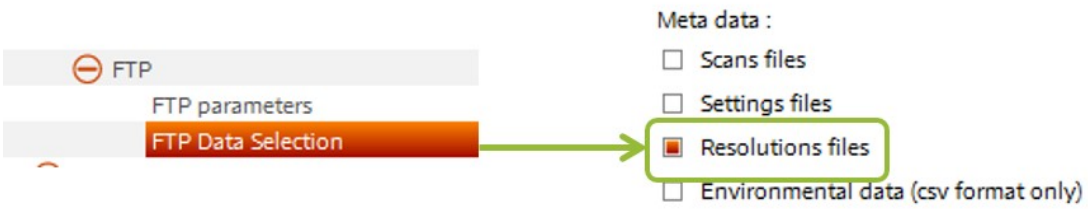
- Scan files will be sent each time they will be played.
- Settings files will be sent every day and for each submit.
- Environmental data will be sent every 30 minutes.
- Other selected data will be exported per sequence.

4.3.19.3 Sending resolution files by FTP

FTP

Resolution files can be exported via the **FTP**.

To do so, tick **Resolutions files**.



- The **Resolutions files** are sent the first time a scan is played after a **START**. If we stop and restart the measurement the **Resolution files** will be sent again and will overwrite the precedents of the same name.
- **Resolutions files** are also resent at midnight (as for scans and settings).

4.3.20 Configuring the synchronization

The LIDAR synchronizes with an internal **GPS** by default. If a **NTP** server is configured, it will be used as a backup if the **GPS** fails or is not plugged.
The system is time synchronised through a **NTP** server or the **GPS**. The management of the synchronisation is done by the Linux NTPD. The synchronisation is cheked every 16 to 1024s in order to keep a max time shift below a few ms. The service is synchronizing **GPS** every 16 seconds and every 64 seconds for **NTP** .

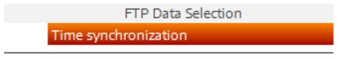
The quality of the synchronization depends on the **GPS** coverage and the quality of the internet network.
Example: if the system is not synchronized for a week, we can observe a time lag of about one second.

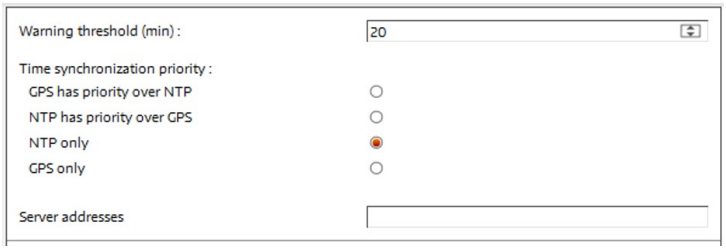
1. Select **Time synchronization**.
2. Set a **Warning threshold**.

   The warning threshold parameter is the threshold above which if no source of synchronization is considered as reliable the status of the time synchronization goes to warning.
   The warning threshold can be defined from 20 to 100,000 minutes.

3. Select a **Time synchronization priority** (choices between **GPS**, **NTP** only or one prior to the other).

4. Set the **Server Address**.

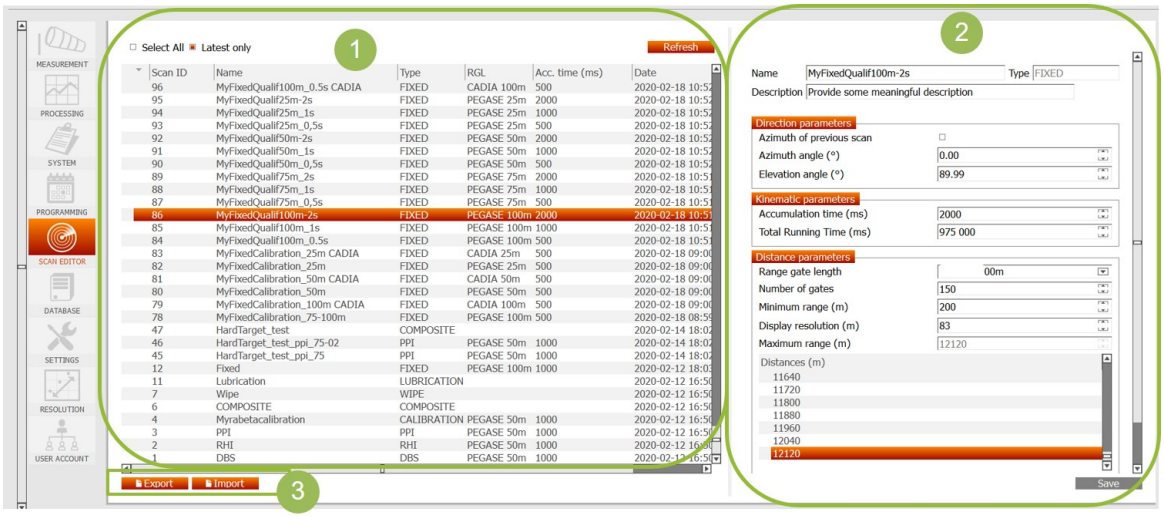




CAUTION! Multiple **NTP** servers are available. Be careful to separate them with a space.
We recommend using the following server addresses:
ntp.ubuntu.com *0.pool.ntp.org* *1.pool.ntp.org* *2.pool.ntp.org* *3.pool.ntp.org*
Servers used for the **NTP** cannot contain the following characters **; | ` : < > &**

- The *last synchronization* corresponds to the last comparison between the **NTP** source selected and the PC Lidar time. If a discrepancy is noted, the behaviour will depend on this discrepancy.
- If the difference is less than one second, the clock frequency of the PC will be increased or decreased until the time is gradually synchronized.
- In the case of a deviation greater than the second (PC not synchronized for a long time), the drift is considered too big and at first the time returned by the source **NTP** will not be considered as reliable and no setting time will be made. After a few minutes, if the time returned by the **NTP** source is still as far from the time of the PC, a brutal time setting will be made.
- In both cases the time setting may take a few minutes.

4.4 Scan editor tab



The **SCAN EDITOR** tab allows configuring your scans (**PPI**, **RHI**, **DBS**, etc.).

Scan editor tab description

1 Scan library
2 Setting of the selected scans
3 Buttons: **EXPORT**, **IMPORT**.

Table 13 Scan editor tab description

Parts	Description
1	Scan library to select and edit all scans contained on the Lidar. The selected scan is highlighted in orange. Right click on a selected scan, to **EXPORT** it or change its **RANGE GATE LENGTH** For each scan are reminded: • Scan ID (unique ID for each scan) • Type of the scan (**DBS**, **PPI**, **RHI**, **FIXED**, etc) • Name of the scan • RGL (**RANGE GATE LENGTH** field) • Acc. time (accumulation time) • Date of creation • User who created the scan NB: The columns `RGL` and `Acc. Time (ms)` are always empty for **Wipe**, **Lubrication** and **Composite** scans which are not associated with a **RANGE GATE LENGTH**.
2	Setting of the selected scans.
3	**EXPORT**, **IMPORT** buttons (more details below).

In the scan library part (1), a "*" displays on the left of a scan when it is being modified.

The * disappears after saving the scan.

4.4.1 Scan description and recommendations

Table 14 Description and recommendations according to the scan type

Scan type	Description and recommendations
PPI	This scan moves the scanning head in azimuth with a constant **elevation angle**.
RHI	This scan moves the scanning head in elevation with a constant **azimuth angle**.
DBS	This scan moves the scanning head into 5 positions (4 cardinal points + 1 vertical beam).
FIXED	This scan points the scanning head into one fixed direction during a defined time. In case of **PBL** option activated, this scan is used for **PBL** height calculation. The following parameters should be used to measure the **PBL** height: • **elevation angle** between 60° and 120° • Total running time (ms) of at least 120s
Wipe	This scan moves the scanning head to the wiping blade to clean up the window. By default, one wipe lasts 1.2 second while using nearly 20 mL. We recommend programming 1 to 2 wipes per day. For instance, a wipe a day will consume 2 liters in 100 days.
Composite	This scan is made of a combination of other existing scans.
Lubrication	This scenario is dedicated to optimize the scanning head maintenance in spreading grease in scanning head gears box (requires also a physical action on the gears box) and allowing you to grease scanning head periodically.
Calibration	**PPI** scan used to calibrate Beta

4.4.2 Azimuth and elevation definition

- The **Azimuth** is the angle between the projection of the line of sight on the local horizontal plane and the geometric North. This angle is between 0° and 360° (0° is the North and 90° is the East).
- The **Elevation** is the angle between the line of sight and the local horizontal plane. This angle is between -90° and 90° (-90° is the Nadir, 90° is the Zenith).

The values in the **STATUS tab** and in the database are real values measured by the scanner sensors. That's why they can oscillate around the configured value in **Scan tab**.
For instance, the **Azimuth** of a **RHI** scan programmed at 0° could oscillate between 0° and 359.999 ° in the statuses and the data.

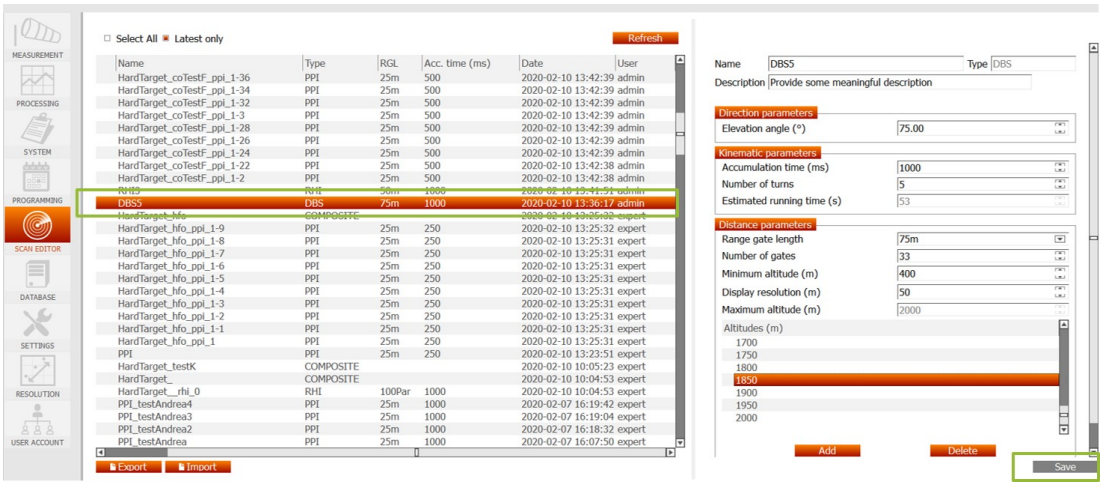
4.4.3 Loading, modifying and saving a scan

Your system is delivered with default scans, one of each type (**PPI**, **RHI**, etc.).

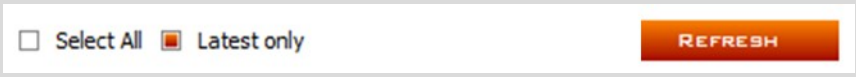
The **DBS** must be configured in the settings (classic or 8). Refer to DBS mode paragraph.

To create your own scans:

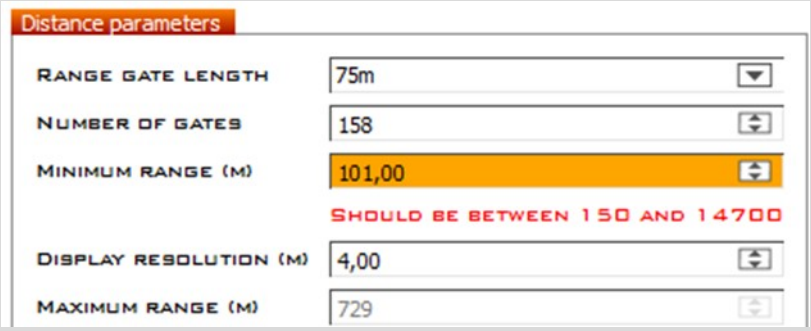
1. Select, in the scan library, the default scan you need to change.
2. Modify some parameters on the right side.
3. Click on **Save** button. New scan is added in your scan library with a new scan **ID**.



- When **Latest only** is checked, if several scans with the same name exist, the one with the highest **ID** will be displayed in the list.



- The **Refresh button** attends to refresh the library if another user, connected in parallel with another GUI, has made any modification.
- For a **Composite**, when checking **Latest only** the library will automatically update.
- Some parameters combinations are forbidden or limited by design. In that case, parameters(s) is(are) displayed in orange and a help message is displayed:

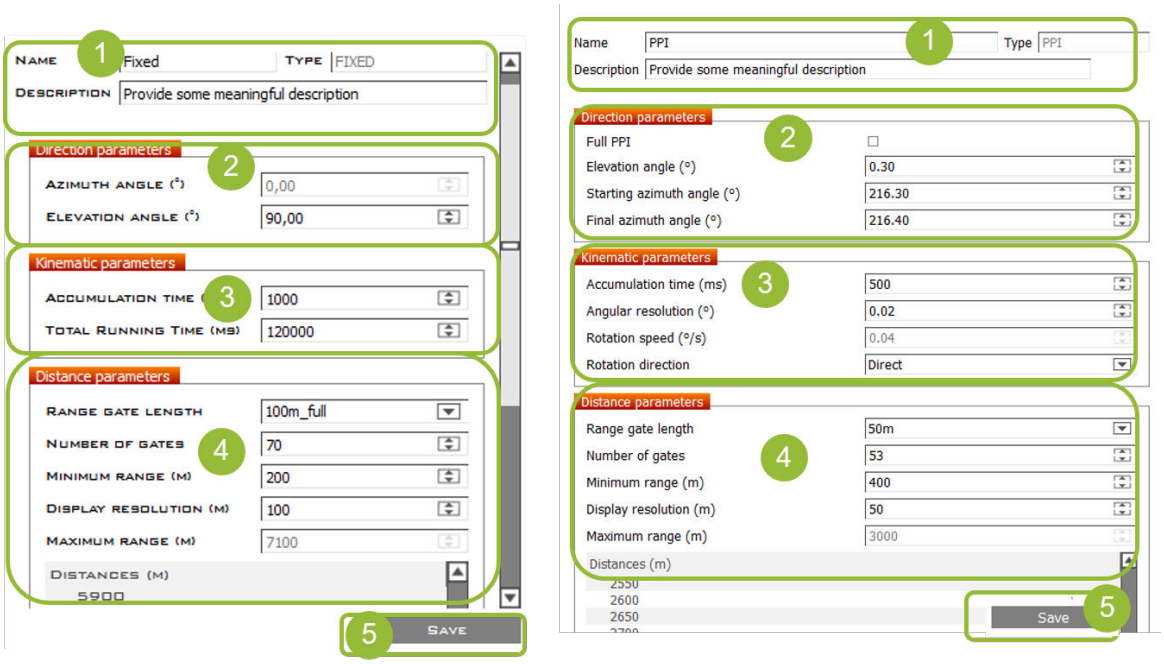


4.4.4 Parameters to configure for all type of scan

Except for some specific scans (**Wipe**, **Lubrication**), the configuration window, on the right panel, is composed of:

- A name, type and a description **(1)**. Maximum of 64 characters for the **Name** field. The **Description** field is limited to 1024 characters. For **Name** and **Description** fields, the only characters allowed are letters, uppercase or lowercase, numbers and - _ + = and space.
- One or several **Direction parameters (2)** to configure the motion amplitude.
- One or several **Kinematic parameters (3)** to configure kinematics and accumulation time.
- **Distance parameters (4)** to configure the positioning of range gates along one line of sight.

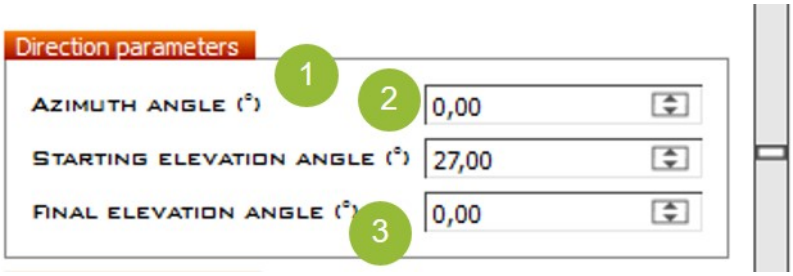
Save button **(5)** remains grayed as long as no changes have been made to a visualized scan.



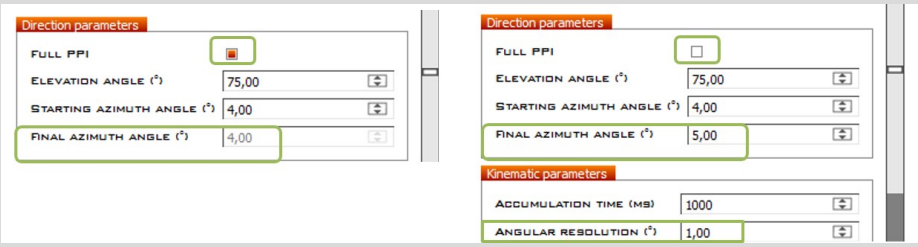
4.4.5 Configuring direction parameters

For **RHI**, the direction parameters consist of an **azimuth angle (1)** and an **Angular resolution** (sector covering from **starting elevation angle (2)** to **final elevation angle (3)**.

For a **PPI**, the **Direction parameters** consist of an **elevation angle** and an **angular range** (sector covering from starting an **azimuth angle** to **final azimuth angle**).

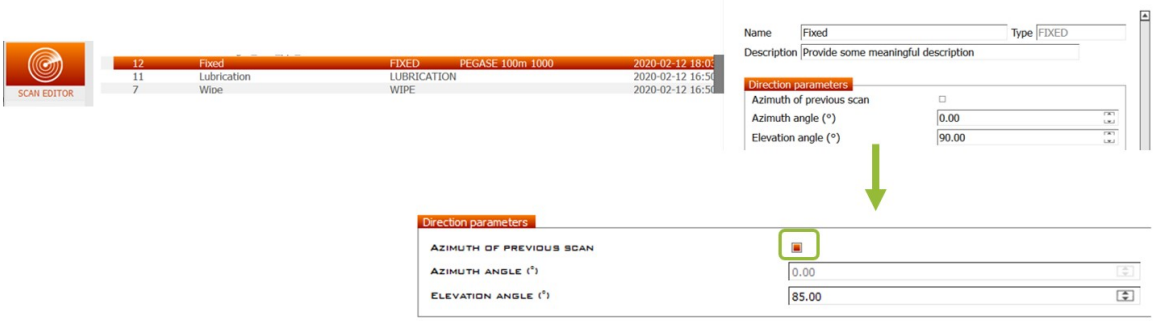


For a **PPI** scan, you can realize a **full PPI**, in other words a complete rotation from any angle of azimuth, by checking the box **full PPI**.



When you untick **full PPI** the value of **final azimuth angle** field is active and changes by default to the values corresponding to **starting azimuth angle** + **angular resolution**. Then you can change the end value.

In order to reduce the travel time between two scenarios, it is possible to set a fixed to 90° with an **Azimuth** different from 0. In addition, you can configure a **FIXED** that will run on the same **Azimuth** as the previous scan. For that, check the box **Azimuth of previous scan** and the **azimuth angle** field will be disabled.



In case of a **FIXED**, the value indicated in the strip on the **Azimuth** of the scan, is the real value of the **Azimuth** and not a theoretical value.

Fixed100m_0.5s 3/10
LOS 45
azimuth = 4.100°
elevation = 2.490°

The value recorded in database will be the last reached **Azimuth**.

Here is an exemple of a programming:

1 In the **LOOP**, we have a **PPI** from 0 to 30° and a **FIXED** at 75° elevation with **Azimuth of previous scan** checked.
2 In the **SCHEDULER** we have a 56° azimuth **RHI**.

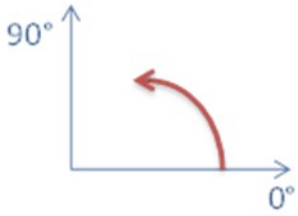
As result, the **FIXED** will be executed at 30° **Azimuth** but if the **FIXED** is interrupted by the **RHI** in the **SCHEDULER**, when the program continues on the **FIXED** as it returns to the **LOOP**, the fixed will run at 56° azimuth.

4.4.6 Configuring kinematic parameters

The **Kinematic parameters** are configured as follows:

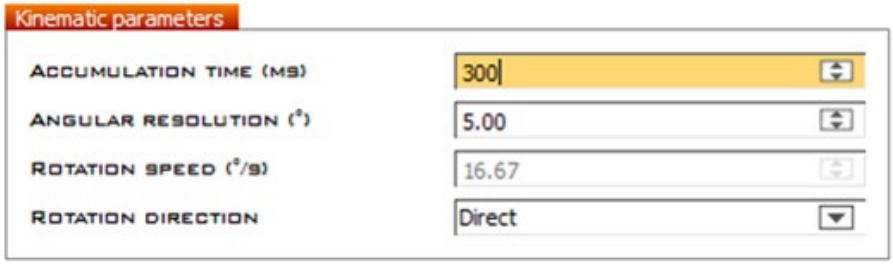
Figure 13 Kinematic parameters

- First, choose an **Accumulation time (1)**.
- For **PPI** and **RHI** scans, **Angular resolution (2)** is used to define the scan.
- For **PPI** and **RHI** scans, **rotation speed (3)** is displayed for information purpose only
- For **PPI**, `direct` in **rotation direction** field **(4)** is clockwise (scan seen from above)
- For **RHI**, `direct` in **rotation direction** field **(4)** is on the direction defined below (scan seen from above):



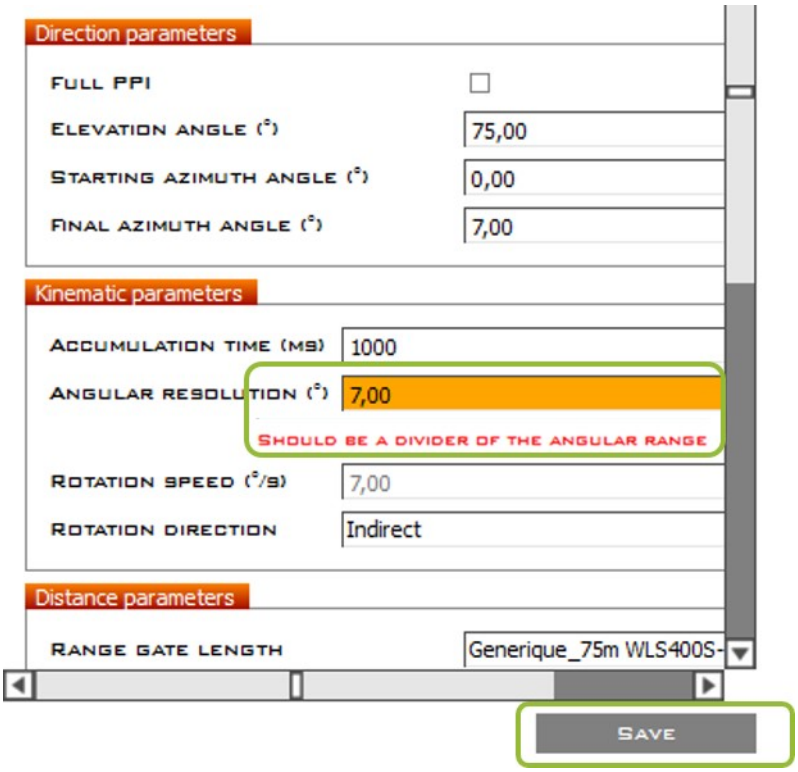
CAUTION! It's possible to set an **Accumulation time** from 10 ms to 10 s. However, CPU and memory loads on the Lidar computer could impair measurement for accumulation times under 100 ms. This will not put the system at risk but could generate missing lines of sight measurement. In that case `Acquisition loop` status will switch to **WARNING** or **CRITICAL** with a message `incomplete reading`.

- We do not recommend to use **accumulation time** lower than 100 ms for an operational campaign without performing a trial beforehand.
- Under 500ms the field will appear in yellow but the scan can still be saved and submitted.

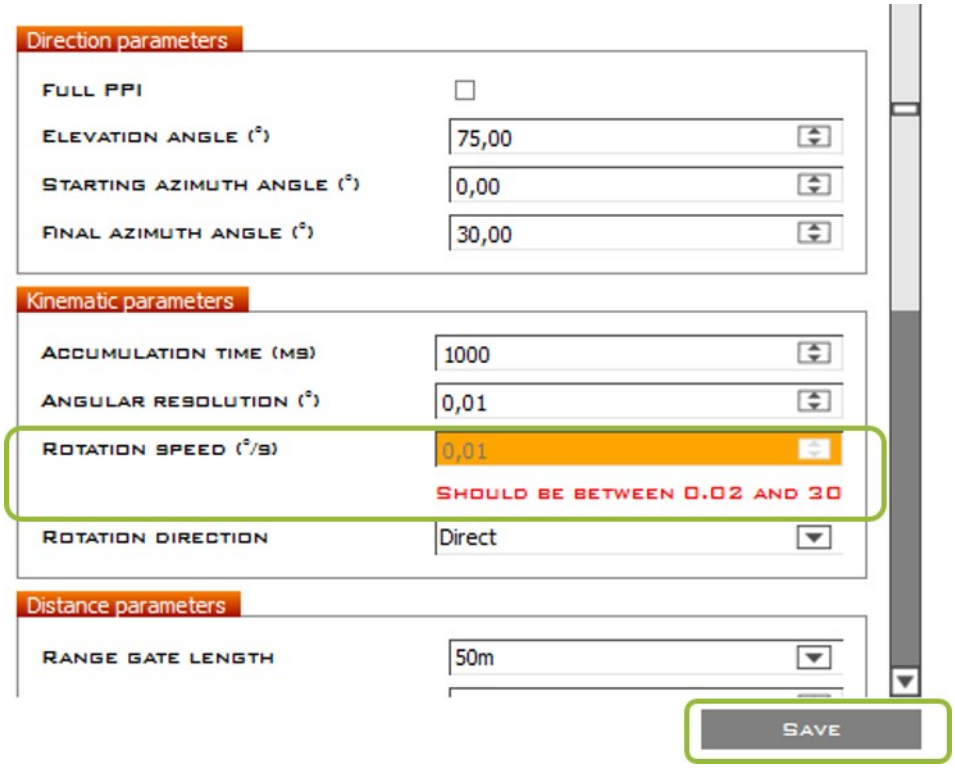


CAUTION! In order to have whole sectors, it is mandatory to seize a scan **which angular range is a multiple of the angular resolution**.

- If it is not the case, **Angular resolution** field becomes orange with an error message and it is impossible to save the scan as long as the combination is not correct.



If the corresponding **Rotation speed** is superior at the threshold of the scanner, the field becomes orange with an error message and the **Save** button is grey and inactive.



4.4.6.1 Case of a DBS scan

The **DBS** mode consists in 5 lines of sight (**LOS**):

- The **number of turns** defines the number of times, the 5 **LOS** will be executed.
- The **Estimated running time** is calculated taking into account the theoretical speed of the scanning head between each **LOS** of the **DBS** + the accumulation time of each **LOS** and the number of turns defined. Therefore, it is updated when one of these parameters is modified.

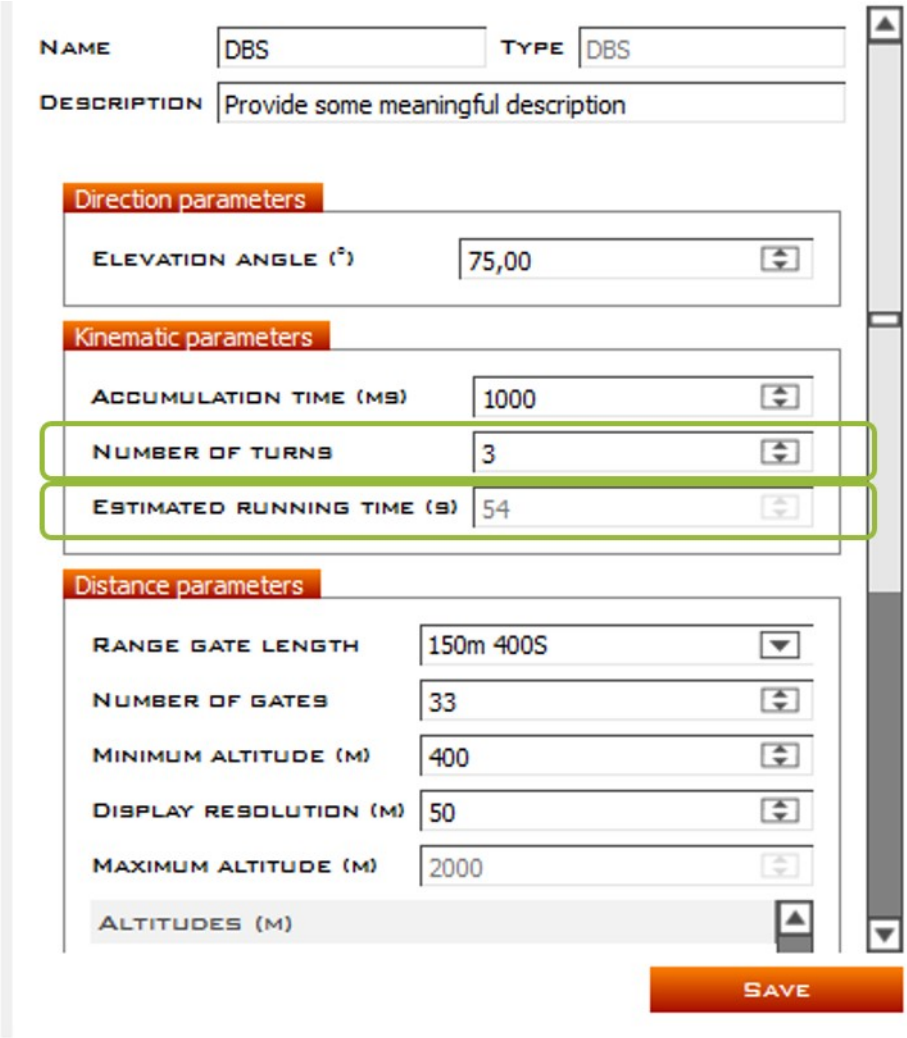


Figure 14 DBS scan

The execution time is optimized and the number of revolutions performed by the scanning head is reduced. By default, the chosen **DBS** will be the one otpimized which performs the **LOS** in the following order:

North (0 °, Elevation) , Vertical (0, 90°), South (0°, 180-Elevation) West (90, 180- Elevation) and East (90, Elevation).

The vertical is now in the 2nd position.

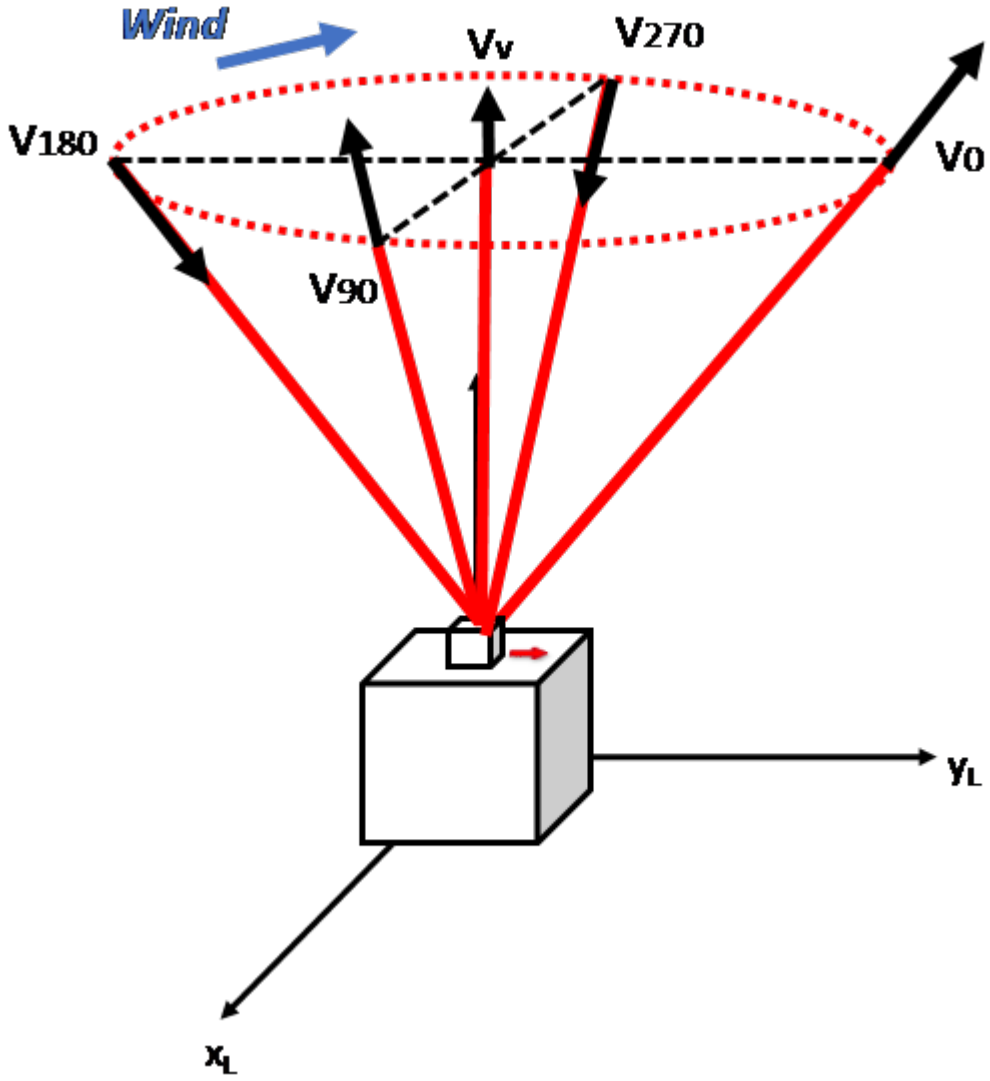


Figure 15 Scheme of the DBS mode

The estimated duration time of the whole scan is 14s.

4.4.7 Configuring the distance parameters

To configure distance parameters:

1. Select a **RANGE GATE LENGTH**, with the drop down menu.
2. Fill the **NUMBER OF GATES**.
3. Fill the **MINIMUM RANGE** (center of the first range gate).
4. Fill the **DISPLAY RESOLUTION** (distance between two consecutive range gates).

5. A list of range gates will be created automatically according to the parameters defined previously.

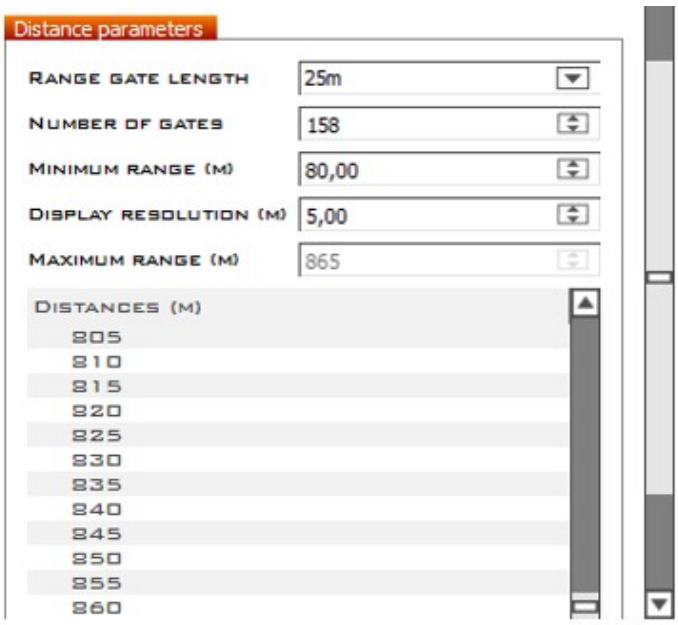


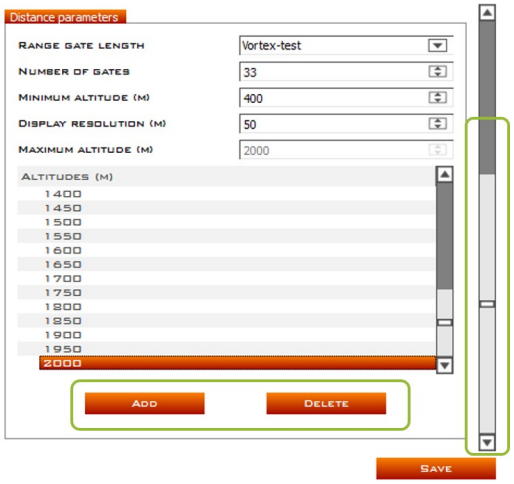
Figure 16 Distance parameters

4.4.7.1 Adding, changing or deleting new range gates

New range gates can be added manually, to do so:

1. Click on **ADD** button to add a new range gate. The user can also change its value manually by double clicking on it.
   a. **Deleting a range gate**
2. Select a range

3. Click on **DELETE** button.



- **ADD** and **DELETE** buttons are accessible by moving the scrollbar on the right.
- The **NUMBER OF GATES**, **MINIMUM RANGE** and **MAXIMAL RANGE** fields automatically update when adding or removing range gates.

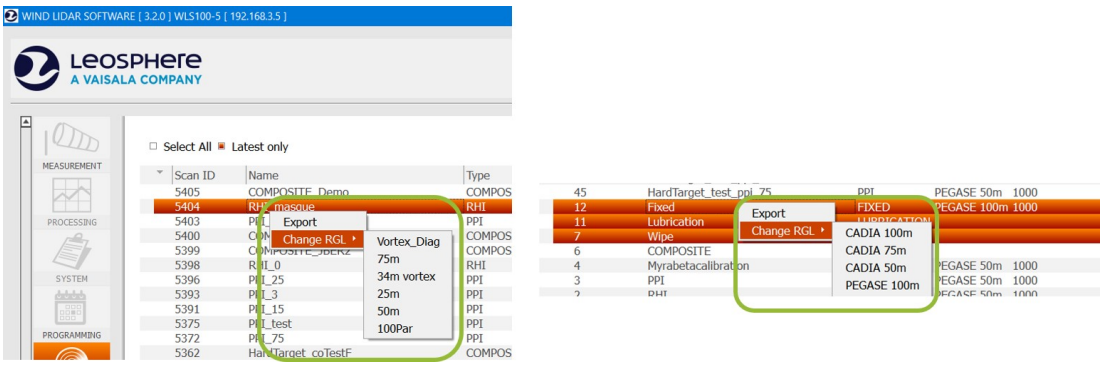
CAUTION! If the user added gates manually, they will be lost if he modifies afterward the distance parameters of the scan.

Changing a range gate length

It's possible to change a **RANGE GATE LENGTH** from one or more scans at the same time. To do so,

4. Open **SCAN EDITOR** tab.
5. Select a scan or more scans

6. Right click on the line(s) and select **Change RGL**.

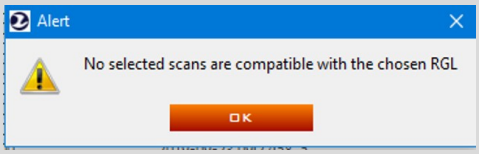


All active and available resolutions are displayed.

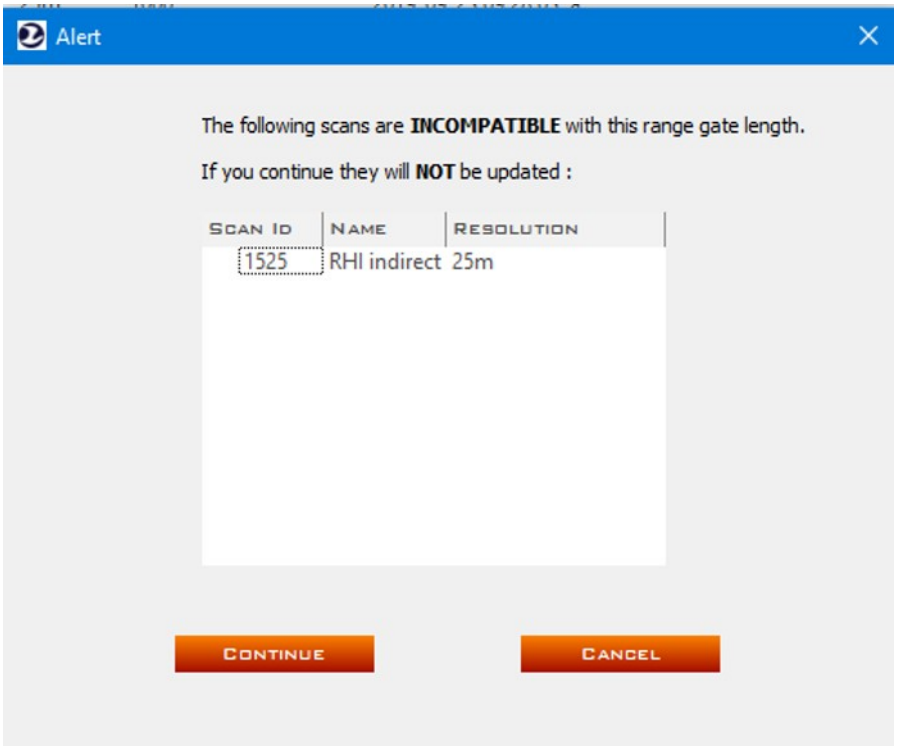
- Choose a **resolution** that will be applied to all selected scans.

However, a check is made to verify that the scan can be switched in this new **resolution**.

If If no selected scan is compatible, the following error message appears:



- If one or more scans (but not all) are not compatible, a window will display. This window summarizing scans that are not compatible and won't be updated:

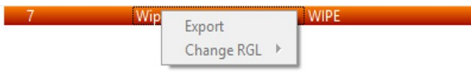


- Clicking on **CONTINUE** button will update all scans not present in this list. A confirmation message indicates then the number of updated scans.
- If a modified scan is part of one or more **Composite**, the **Composite** is also updated and saved again. This is also the case when a scan is "normally" saved and is part of a **Composite**.

All composites containing a modified scan in the **SCAN EDITOR** tab will be saved again in the **SCAN EDITOR**. This way, the programming can be automatically updated with the new information of the composites.

CAUTION! Limitations

- The modification of the **RANGE GATE LENGTH** cannot be done if **latest only** is unchecked, nor on the archived scans. In these cases it is necessary to use the classical **Save** method.
- The right click actions is not possible with a **Wipe** scan.



4.4.8 Distance parameters limitations

Depending on your scanning Lidar model some parameters are inter-dependent and must be configured in the boundaries given in the following tables:

Table 15 Boundaries for distance parameters

Product	Range gate length (m)	Distance max (m)	Distance min (m)	Max gate number
100S	100	14700	200	159
	75	14700	150	319
	50	7200	100	319
	25	3300	50	259
	34_Vortex	7200	70	158
200S	100	14700	200	159
	75	14700	150	319
	50	7200	100	319
	25	3300	50	259
	34_Vortex	7200	70	158
400S(-AT)	200	19500	400	79
	150	14300	300	159
	100	7200	200	159
	75	7200	150	319

4.4.9 Exporting a scan

It is possible to **IMPORT** and **EXPORT** one or several scans from, or to a local directory. To do so:

1. Select, from the library, the scans you need. It's possible to select various scans by holding down the **CTRL** key (**CTRL** key + click).
2. Click on **EXPORT**. The **EXPORT SCANS** window opens.
3. Select a folder to export your scans.

4. Click on **Select a folder**.

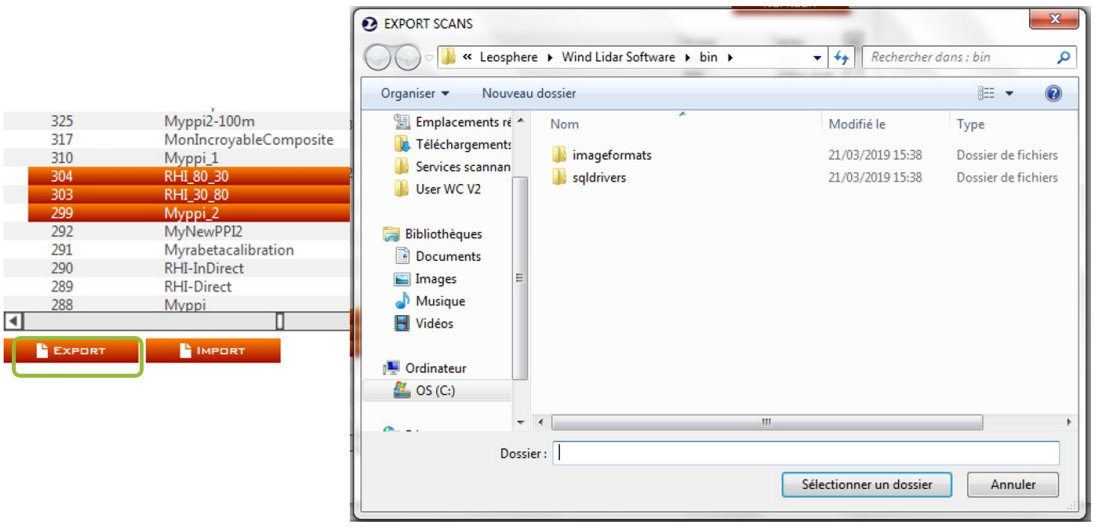
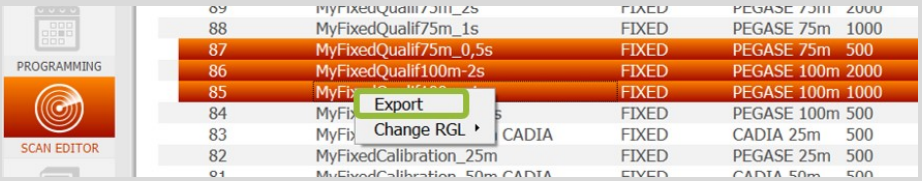


Figure 17 Exporting a scan

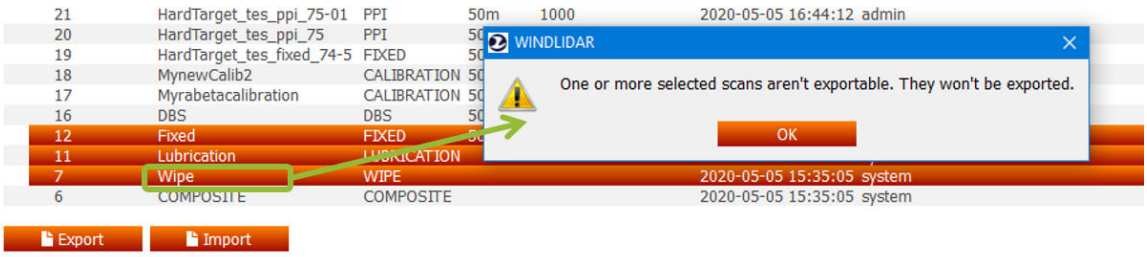
When one or more scans are selected, you can also right-click on the scan table to export the selected scans, the same **EXPORT SCANS** window opens.



If you need to export all the scans you can check the box **Select all**.
All the scans are exported in the same directory, selected by the user, and are automatically named "*SystemID_ScanID_ScanName.scan*".

CAUTION! Disabled scans cannot be exported.

If you select one or more scans that are not exportable (**Wipe**, or disabled scan), they won't be exported and the following message will display:



More information

- Scan, settings and resolutions files (page 154)

4.4.10 Importing a scan

1. Click on **IMPORT** button.
2. The **IMPORT SCANS** window opens.
3. Select scans you need to import. It's possible to select various scans by holding down the CTRL key (**CTRL** key + click).
4. Click on **Open** button. A popup window opens.
5. Select the **RANGE GATE LENGTH** to apply.

6. Click on **OK**. The selected scans are now imported.

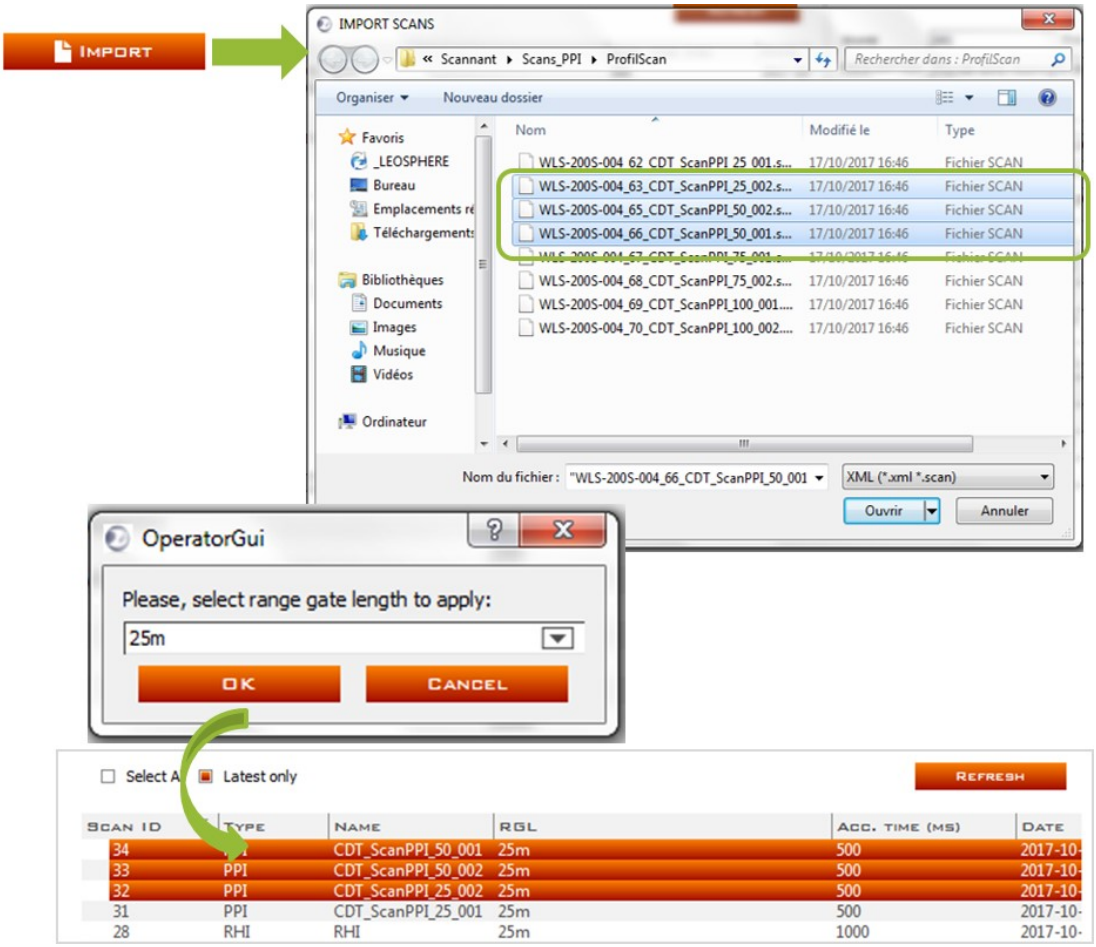
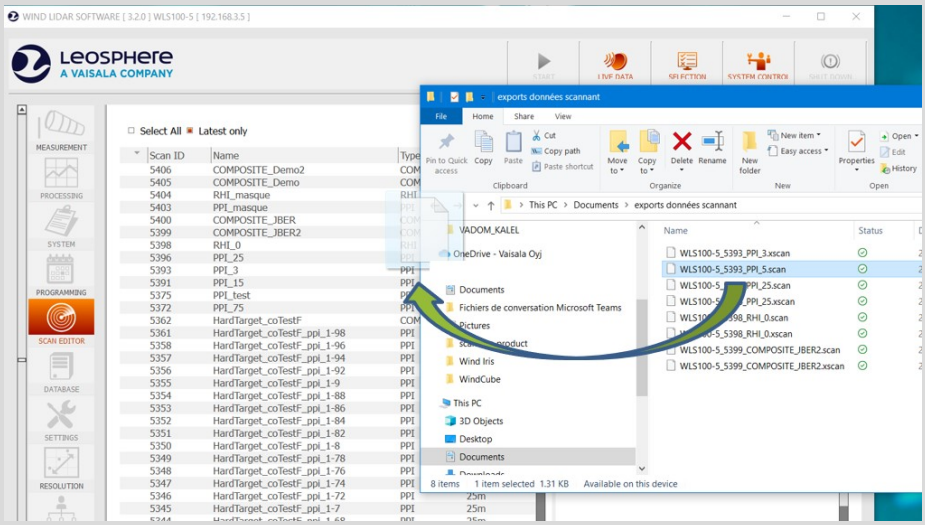


Figure 18 Importing a scan

- In case of a group of imported scans at the same time, only one **RANGE GATE LENGTH** can be applied to the group. To associate different range gate lengths, you need to do several imports.
- If the distance parameters of an imported scan are not compatible with the associated **RANGE GATE LENGTH**, the scan will be saved as disabled.

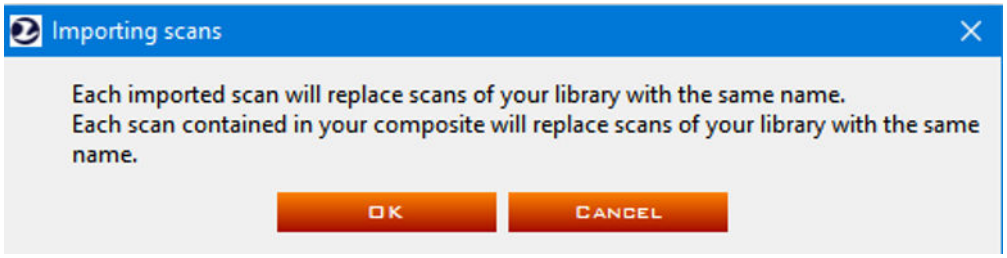
You can import a scan by a drag and drop, directly in the **SCAN EDITOR** tab.



According to the imported scan, you will receive a message warning you that each imported scan will replace scans of your library with the same name. Then, in a another pop-up, you will have to select a **RANGE GATE LENGTH** to apply.

- The import of a `.xscan` is not possible.

If a **Composite** scan is imported and the library already has scans with the same name (the **Composite** scan or its elementary scans), the imported scans will replace the existing ones in the library.

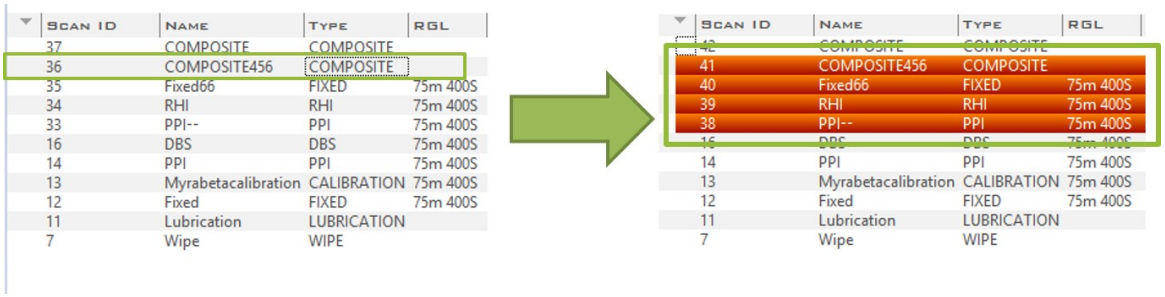


- Note that these scans will remain accessible if the user unchecks the box **latest only**.

If you click on **OK**, the **Composite** is therefore saved (with a new **ID**), as well as the elementary scans and all the other composites that could contain these scans.

Here is an example:

The **Composite** 456 is re-imported and contained scans with **ID** 35, 34 and 33.



Scan ID	Name	Type	RGL
37	COMPOSITE	COMPOSITE	
36	COMPOSITE456	COMPOSITE	
35	Fixed66	FIXED	75m 400S
34	RHI	RHI	75m 400S
33	PPI--	PPI	75m 400S
16	DBS	DBS	75m 400S
14	PPI	PPI	75m 400S
13	Myrabetacalibration	CALIBRATION	75m 400S
12	Fixed	FIXED	75m 400S
11	Lubrication	LUBRICATION	
7	Wipe	WIPE	

Scan ID	Name	Type	RGL
41	COMPOSITE456	COMPOSITE	
40	Fixed66	FIXED	75m 400S
39	RHI	RHI	75m 400S
38	PPI--	PPI	75m 400S
14	PPI	PPI	75m 400S
13	Myrabetacalibration	CALIBRATION	75m 400S
12	Fixed	FIXED	75m 400S
11	Lubrication	LUBRICATION	
7	Wipe	WIPE	

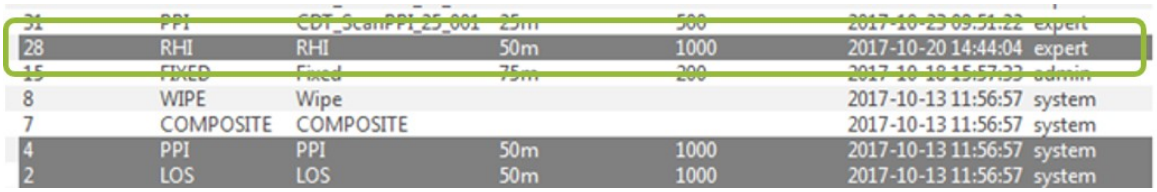
The **Composite** 456 with the **ID** 36 containing the same elementary scans is saved under the **ID** 41.

The **Wipe** scans contained in a **Composite** will not be saved with a new **ID** but will still be contained in a re-imported **Composite**.

4.4.11 Disabled scan

A scan is automatically disabled if it is imported and associated to an incompatible **RANGE GATE LENGTH**. The scan can be reactivated by setting it with valid **RANGE GATE LENGTH** and distance parameters and saving it.

When a scan is disabled, it is displayed in dark gray background and is no longer visible in the list of programmable scans on programming tab:

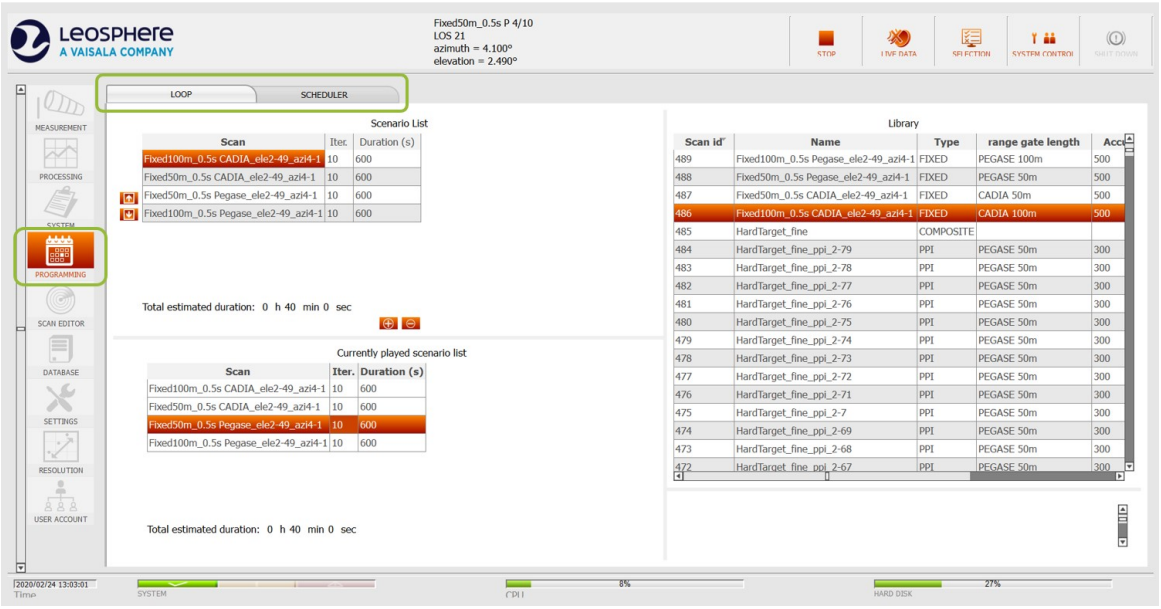


28	RHI	RHI	50m	1000	2017-10-20 14:44:04	expert
8	WIPE	Wipe			2017-10-13 11:56:57	system
7	COMPOSITE	COMPOSITE			2017-10-13 11:56:57	system
4	PPI	PPI	50m	1000	2017-10-13 11:56:57	system
2	LOS	LOS	50m	1000	2017-10-13 11:56:57	system

CAUTION! An archived scan should always be reactivated for **Composite** use: because an archived scan will not be updated in a **Composite**. In that case, it will disappear from the **Composite** definition but will be played in its previous version.

4.5 Programming tab

The **PROGRAMMING** tab is composed of two subtabs **LOOP** and **SCHEDULER**:



4.5.1 Programming several scan from LOOP window

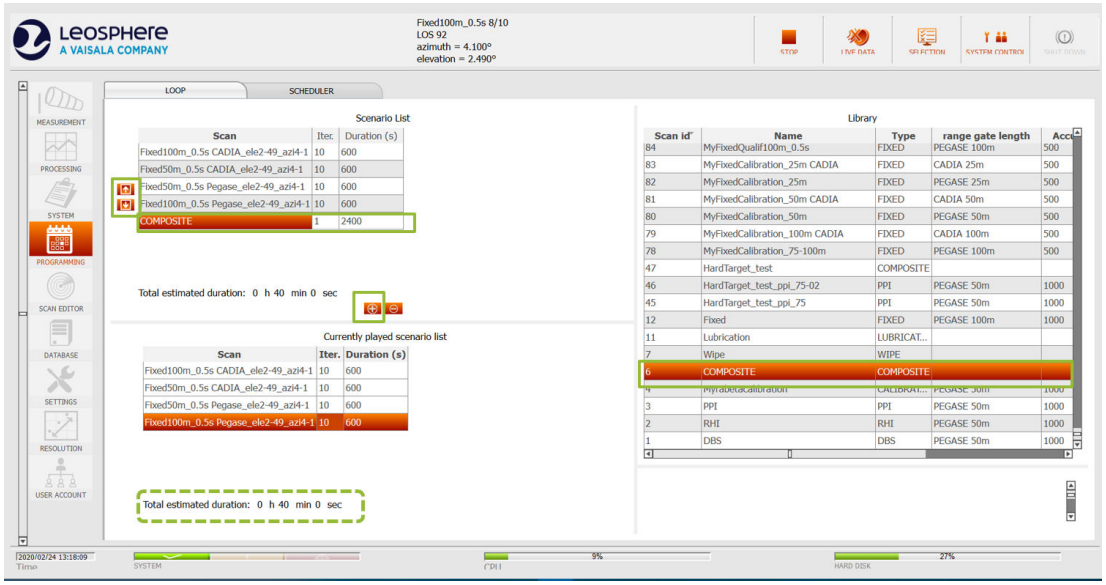
The Lidar can be programmed to play several scans in a **LOOP** (cyclic program).

> At a beginning of a scan, the first measurements can be slightly noisy due to laser heating time.

To configure a program with several scans:

1. Take control of the system by clicking on **SYSTEM CONTROL**.
2. Add a line with the **+ button**.
3. Select the box in the column **scan**. On the right, the scans library is displayed.
4. Click on one scan and check its parameters below.
5. Double-click on the desired scan.

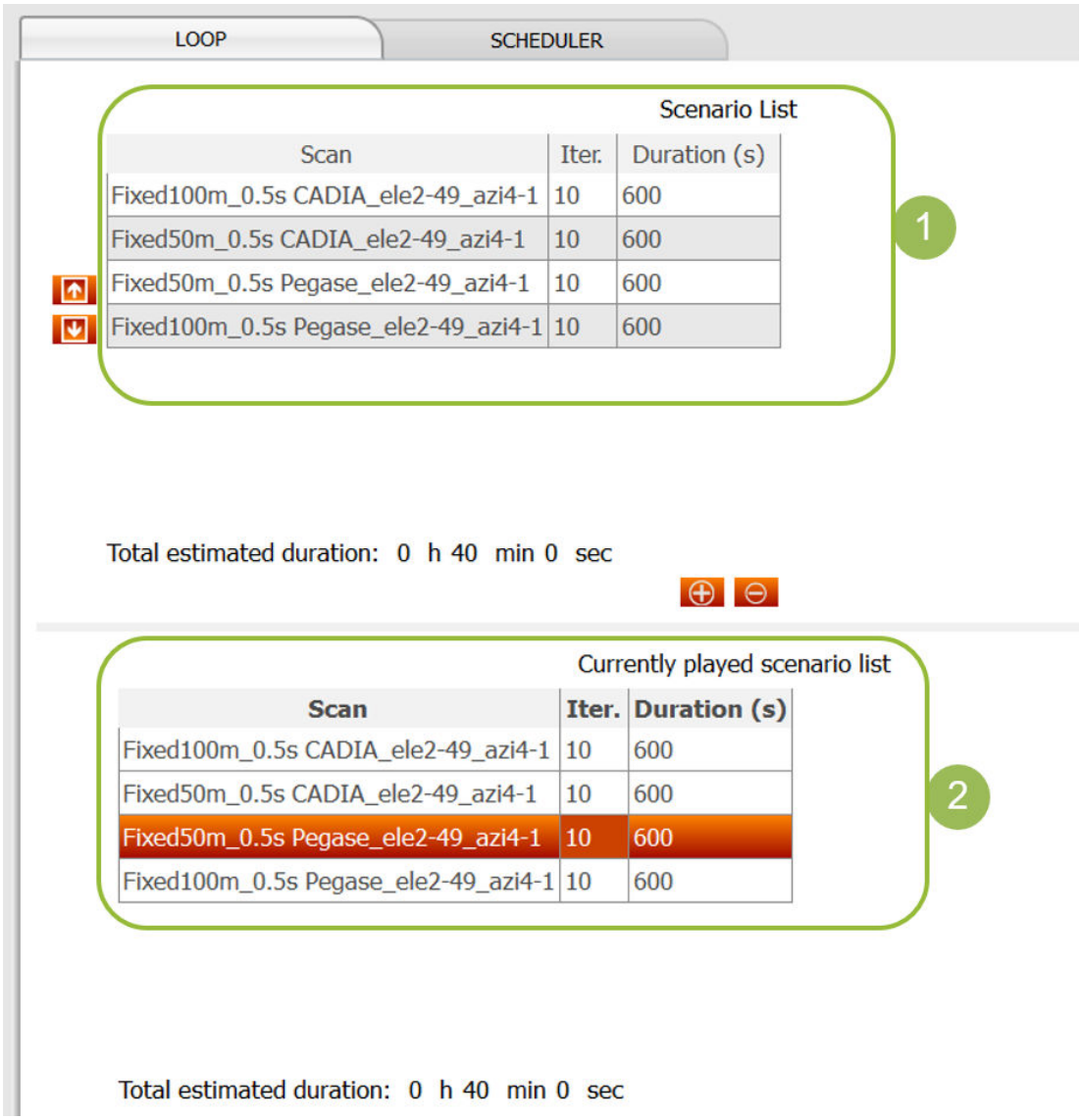
6. Fill the Iteration field.



- It is possible to see the current programing while setting a new one.

In the **LOOP** and **SCHEDULER** sub-tabs, the **Duration** column indicates the duration, in second, of each line of the program. The displayed duration takes into account the number of iterations and also the repositioning time between each iteration for a given line. In the **LOOP** tab, at the bottom of the page, displays the total estimated duration of the **LOOP** scenarios.

- For the calculation of the duration of a **Composite**, the travel time between 2 scans of the **Composite** is considered.
- This duration takes into account the time unit of each scan play and also the repositioning time between each line of the programming. For the first scenario, it is considered that the scanner is already in position.

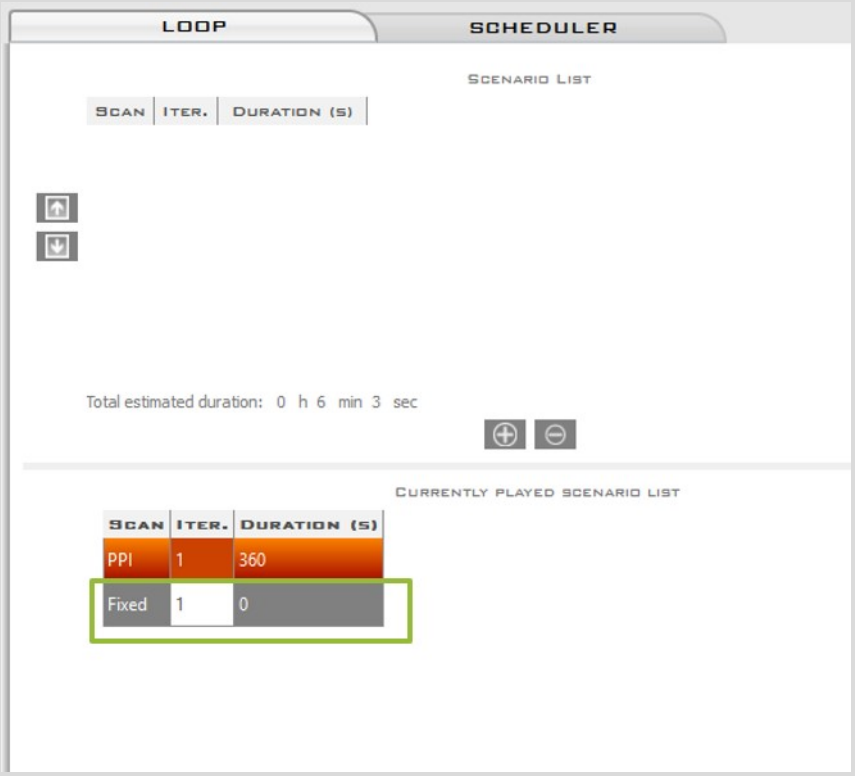


1 Scenario list, in construction

2 Currently played scenario list (being played or the last played). This part highlights the line that is being played. This highlighted line also appears when the user only has live data. This table is refreshed every 30 seconds and when passing from one scan to another.

If scans are programmed in both **LOOP** and **SCHEDULER** tabs, the user will have the highlighted line only in the tab where the scan is played.

- The current scenario is visible with live data and can be visualized without system control.
- In this case, the programming "in progress" is not visible you can only see the current programming, which is simply greyed out (valid for **LOOP** or **SCHEDULER**).
- The scan currently played is always highlighted.



In this case, the library is not accessible.

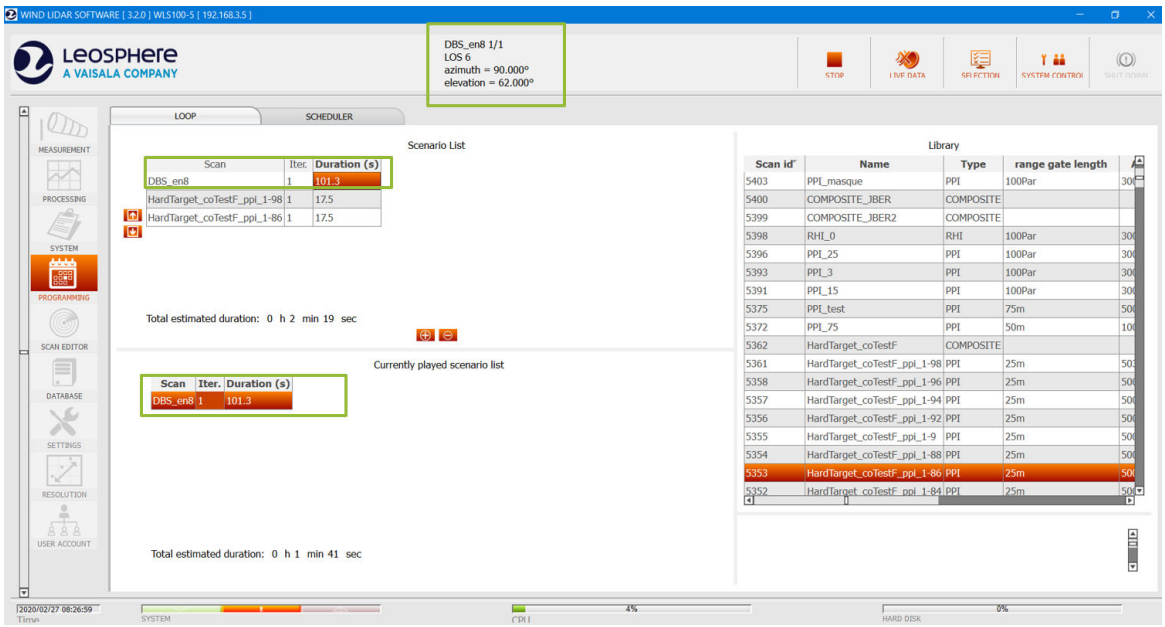
To add another scan, repeat the operation from the second step. Repeat this process as many times as needed.
The scans order can be chosen using arrows on the left.

CAUTION! Note that in case a program contains consecutive scenarios with different **RANGE GATE LENGTH**, a transition program must be added, in order to let the laser heating up.
For example, if a cyclic program is composed of a **PPI** with a **RANGE GATE LENGTH** of 75m, and a **PPI** with a **RANGE GATE LENGTH** of 50m in a row, it is advised to run a **FIXED** for 30 seconds before any change of **RANGE GATE LENGTH**. So that the final program would be:

- **PPI** with a **RANGE GATE LENGTH** of 75 m,
- **FIXED** with a **RANGE GATE LENGTH** of 50 m for 30 seconds,
- **PPI** with a **RANGE GATE LENGTH** of 50 m,
- **FIXED** with a **RANGE GATE LENGTH** of 75 m for 30 seconds,
- **PPI** with a **RANGE GATE LENGTH** of 75 m.

In the Library part, you can choose the display order of the columns. They can be moved by clicking on one column and dragging it.

In order to know, which scan is being played, the banner on top of the page allows you to visualize which scan is played and its iteration.



In case of a **Composite**, only the information about the basic scan played will display in the banner.

If another user is working from another graphical interface, the programming will be updated after a maximum of 30 seconds.

4.5.2 Scheduler sub-tab

From this sub-tab, you can schedule one or more scans.

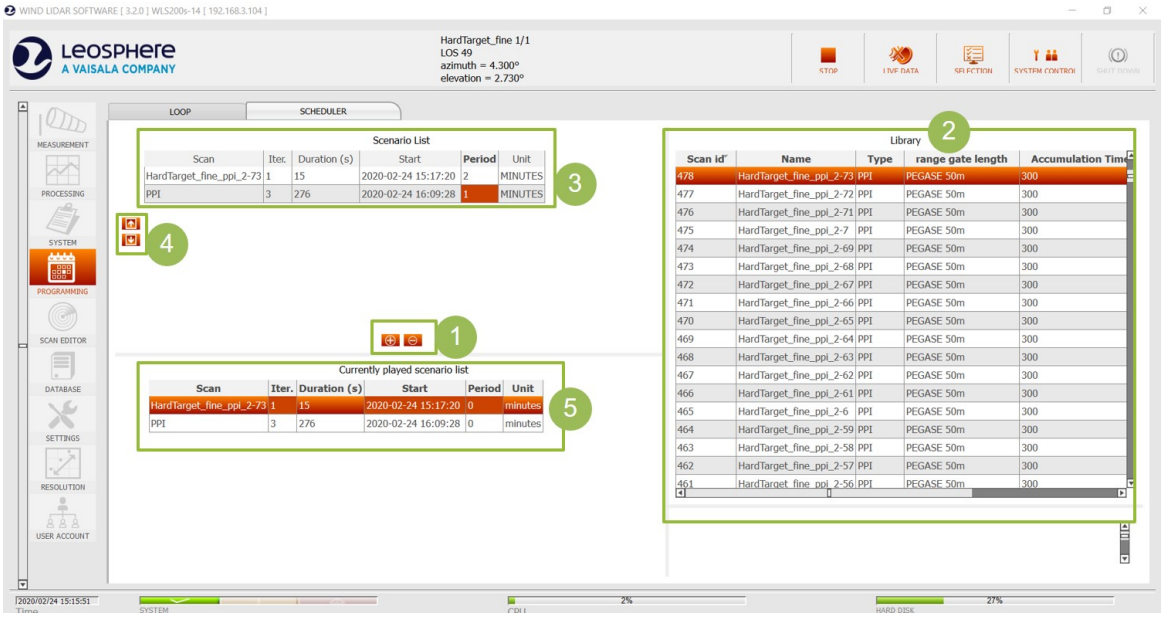


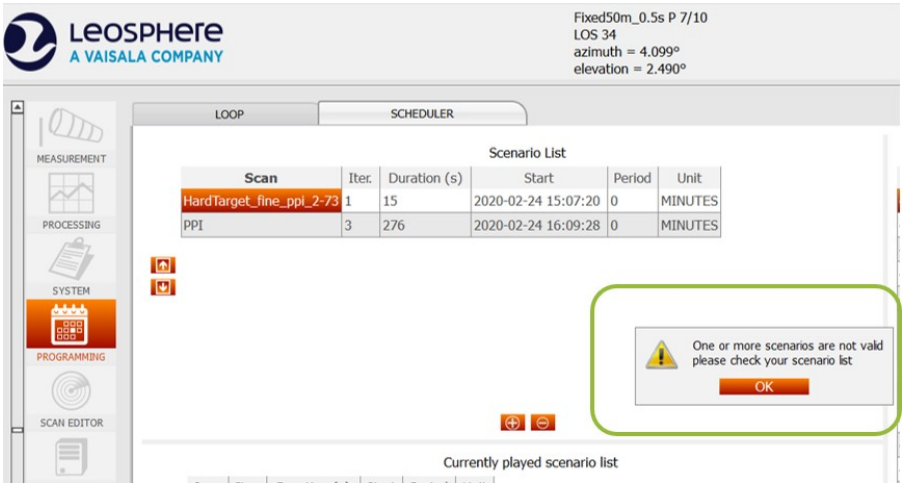
Figure 19 Scheduler sub-tab presentation

1 **+ and - buttons**. Buttons to add add or delete a line. For adding a line and create a scenario, click on **+ button**
2 Library of scans.
3 Scenario of scans being created.
4 Arrows to push up or down a scan in the list
5 Currently played scenario list (scan being played or the last played). This part highlights the line that is being played. This highlighted line also appears when the user only has live data. This table is refreshed every 30 seconds and when passing from one scan to another.

In Part 3, scenario list, if some scans of the list have been updated, in parallel, in the **SCAN EDITOR**, they will be automatically updated in the "in progress" programming so that the user can see the changes (like a new duration for example). The user will be warned, at the **START**, that scans have been modified. This way, you always have the choice to play or resave the old ones.

It's possible to schedule scans only from the **SCHEDULER** sub-tab without entering anything in the **LOOP** sub-tab. So, you can run some scans in the **SCHEDULER** with absolutly no scan in the **LOOP**.

CAUTION! Nevertheless, it won't work if a scan is programmed with 0 as periodicity. Indeed, it must have its execution time at least 1 minute longer than the current UTC date, otherwise the following message will be displayed and it will be necessary to change the execution date of the scenario.



4.5.2.1 Scheduling a program with several scans

Additionally to a **LOOP** program, the Lidar can be programmed to play several scans at a predefined date.

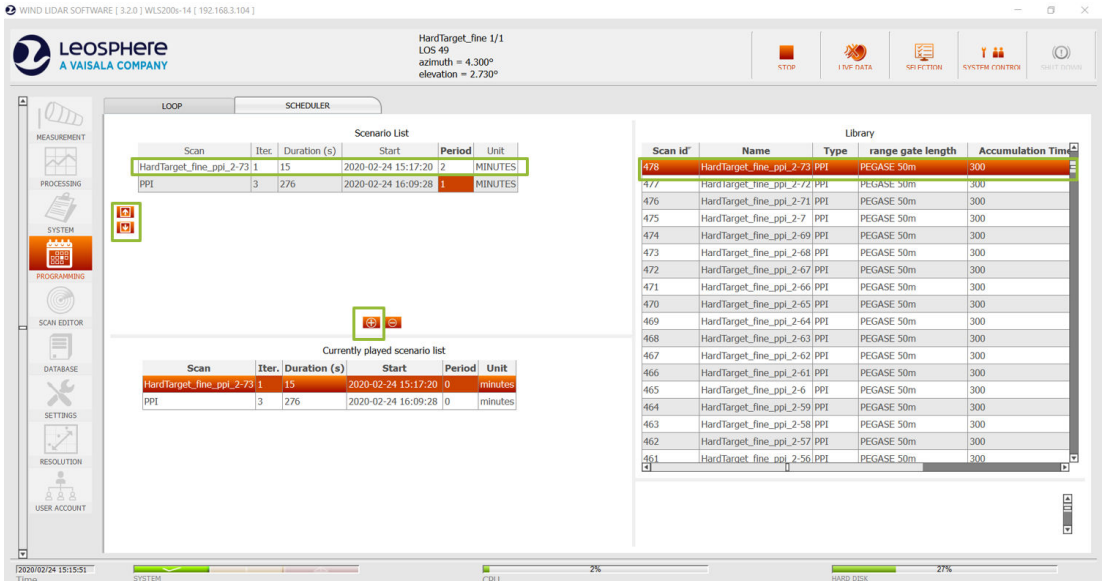
In case another scan is running, it is automatically and immediately stopped to let the scheduled program run. When the scheduler scan is finished, the loop restarts at the beginning of the scan previously interrupted.

In case of several scheduled scans, if one is not finished and the next one must start, the previous one will be interrupted. Indeed, a scheduled scan always stop another scheduled scan.

To schedule a program with several scans:

1. Take control of the system by clicking on **SYSTEM CONTROL**.
2. Add a line with the **+ button**.
3. Select the box in the **scan** column. On the right, the scans library is displayed.
4. Click on one scan and check its parameters below.
5. Double-click on the desired scan.
6. Fill the **Iteration** field.

7. Fill the **START** field with the first time on which to play the scan.
8. Fill the **PERIOD** field with the period on which to play the scan.
9. Fill the **UNIT** field (between minutes, hours, days or weeks).



- Once the scenario is started, the **START**/**STOP** button is not greyed out.
- The **SCHEDULER** can be stopped before the first scan runs and the acquisition state in the Lidar status will only appears as acquiring only when a scan is being played.
- The **START**/**STOP** button stays with the stop icon even if the Lidar is not currently running a scan, that way it's possible to know if a scheduler was launched.

- A delay might take place between the start time (when the scan will be launched) and the time of the first **LOS** acquired. This delay includes the scan moving towards the start position and the scan programming.
- If a scan has duration greater than its periodicity, it is stopped and restarts from the beginning. The periodicity is a priority over the duration.
- If 2 scenarios are defined to start at the same time but do not have the same periodicity the second scenario will run on its next run date (or iteration).

CAUTION!

- If the same start time is filled for 2 scans with the same periodicity the **SCHEDULER** will not be triggered.

4.6 Resolution tab

The **RESOLUTION tab** is only accessible for Expert profile.

A **resolution** is an *advanced setting* containing all parameters linked to the **RANGE GATE LENGTH** and the laser pulse. The Lidar contains at least 4 resolutions: one for each **RANGE GATE LENGTH**.

The **RESOLUTION tab** allows managing the factory configurations if asked by Customer Service concerning diagnosis and maintenance.

4.6.1 Exporting resolutions

1. Click on **RESOLUTION tab**.
2. The **resolution** window opens containing the list of factory configurations.

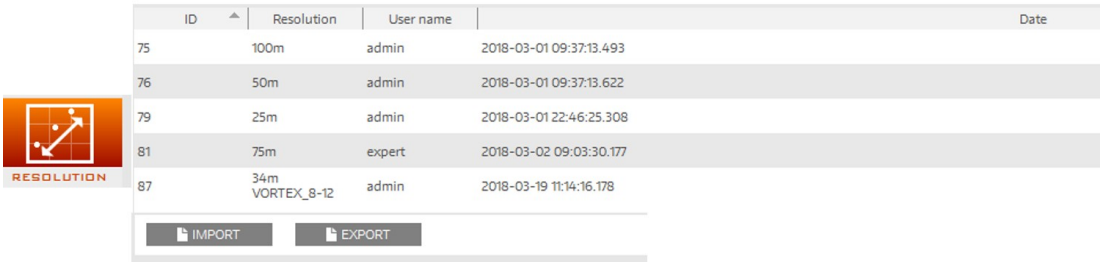


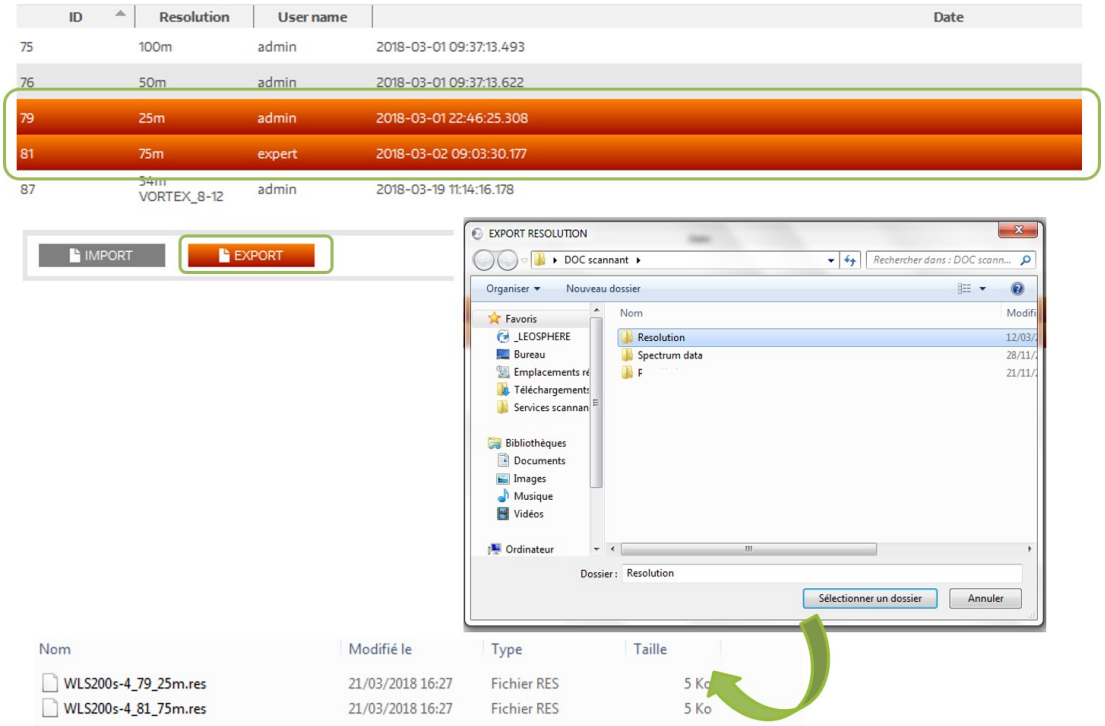
Figure 20 Exporting resolutions

4.6.2 Exporting one or more resolutions

If needed, you can export more than one resolution. To do so:

1. Select one or more resolution.
2. Click on **EXPORT** button. The **EXPORT RESOLUTION** window opens.
3. Select a folder.
4. Click on **Select a folder** button.

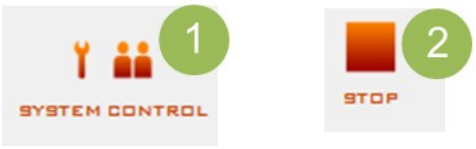
5. All the resolutions files will be exported in this folder and will automatically be named `<IDSystem>_<IDResolution>_<ResolutionName.res>`.



4.6.3 Importing resolutions

To import a **resolution** you must **take control** and **stop measurements**.

1. Click on **SYSTEM CONTROL** to **take control** on the system.
2. Stop measurement.



3. Click on the **IMPORT** button.
4. The **IMPORT RESOLUTION** window opens.
5. Select a **resolution** to import.
6. Click on **Open**. The **resolution** is added in the list replacing, with a new **ID**, the previous **resolution** of the same type.

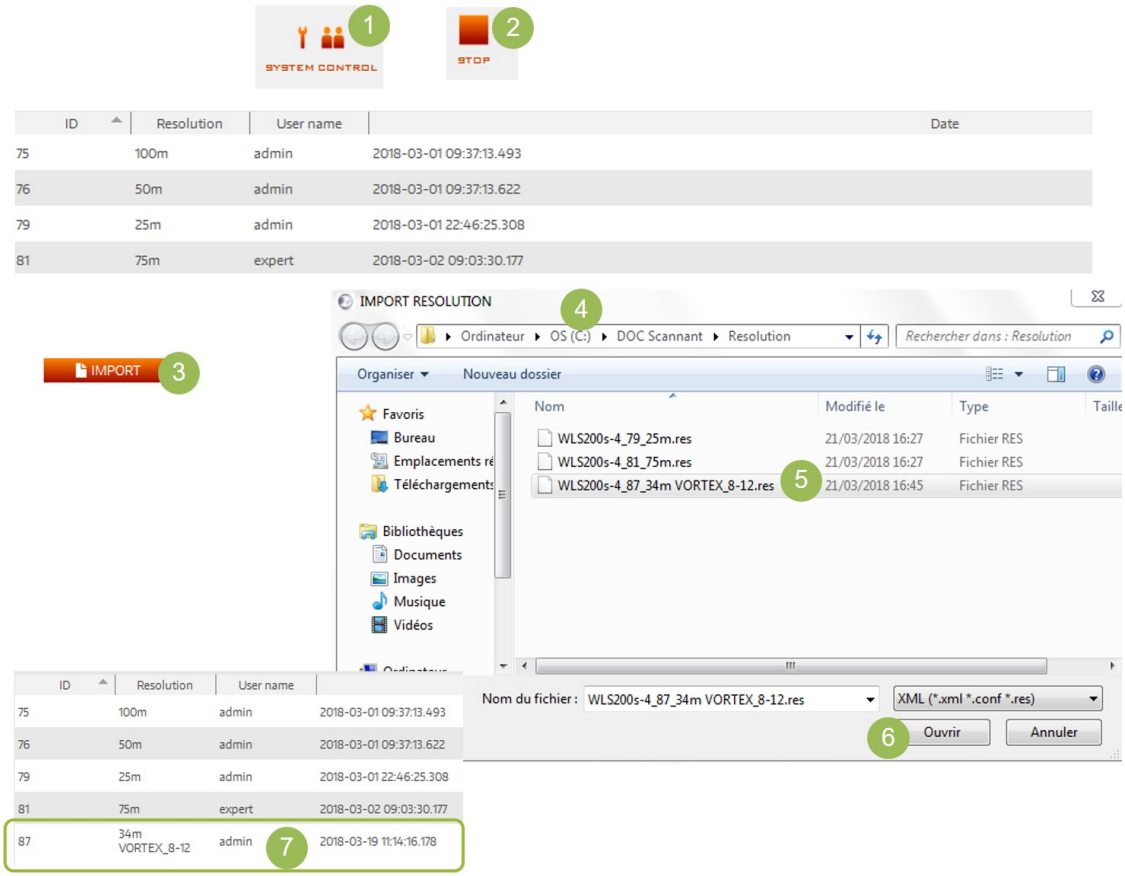
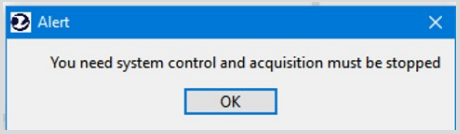


Figure 21 Importing resolutions

As for the import of the scan, you can also import resolutions using the drag and drop method. To do this you must always have the **SYSTEM CONTROL** and stop the acquisition, otherwise a message will remind you to do so.



5. Monitor the Lidar

5.1 Displaying live data

At first connection, you can:

1. Select data type to display by clicking on **SELECTION** button.
2. Click on **LIVE DATA** to display the data.
3. The **LIVE DATA** button turns on and graphs are displayed.

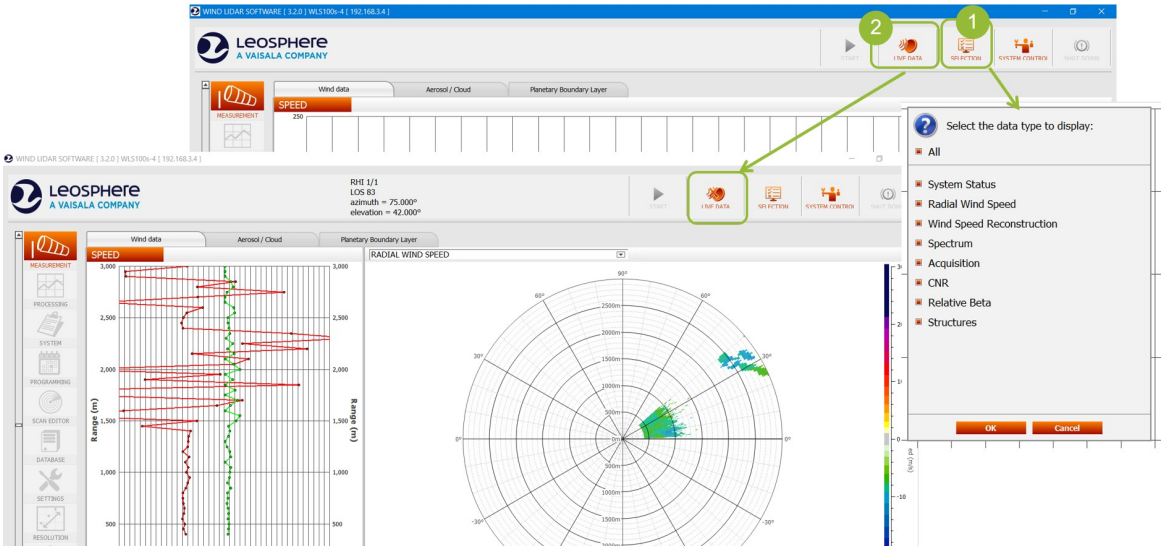
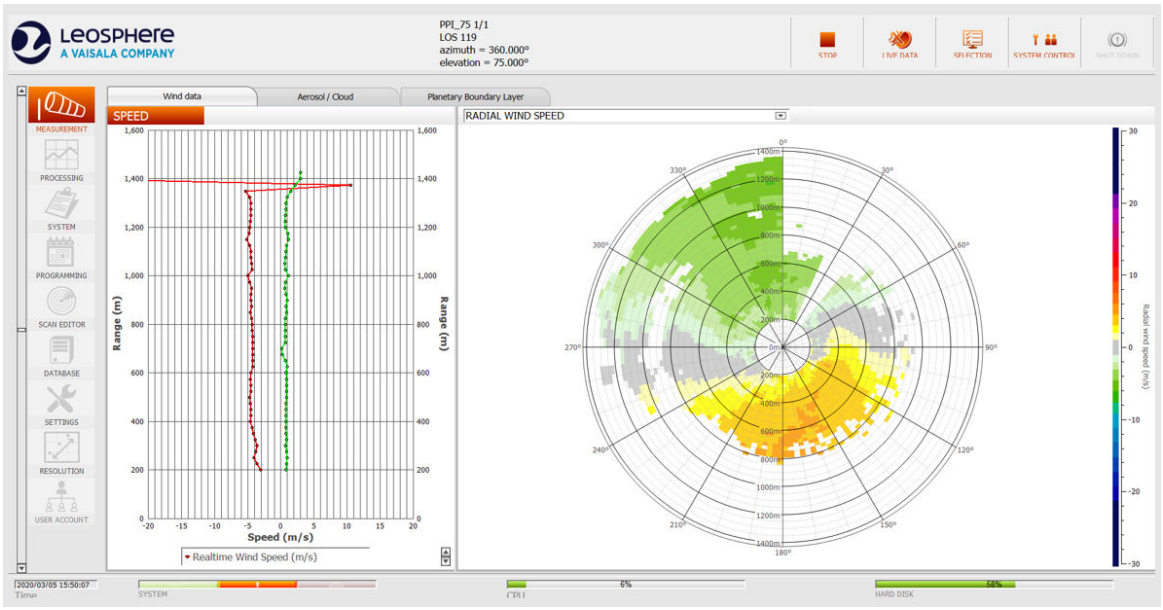


Figure 22 Displaying live data

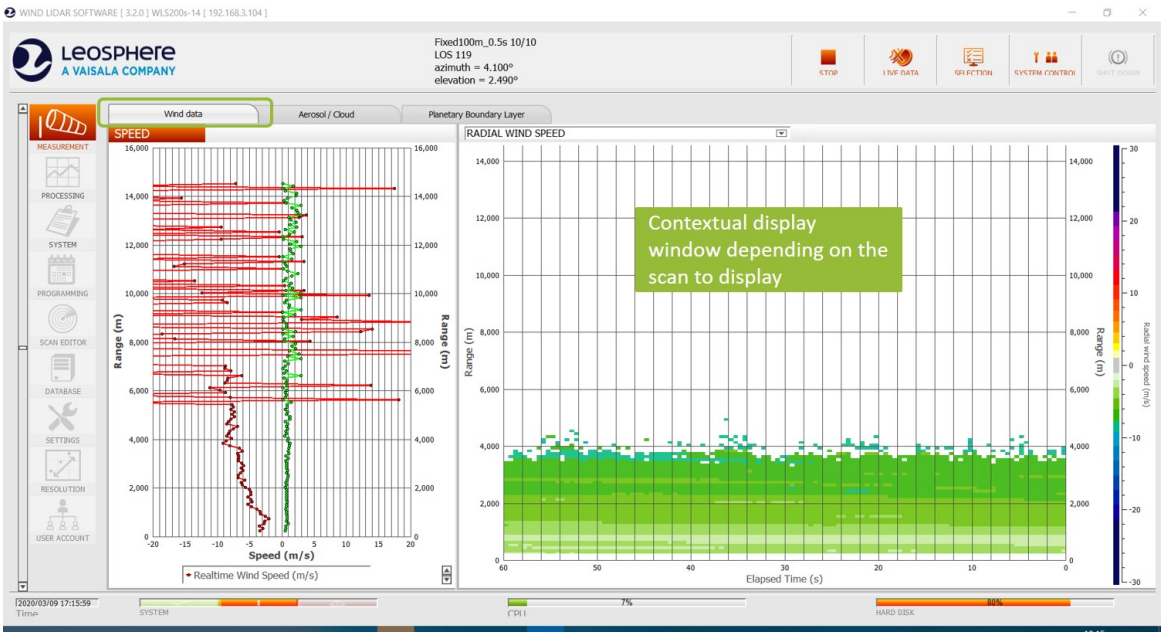
5.2 Measurement tab

The **MEASUREMENT TAB** displays real-time wind speed, radial wind speed and speed dispersion. The tab has 3 sub-tabs: **WIND DATA**, **AEROSOL/CLOUD** and **PLANETARY BOUNDARY LAYER**.



5.2.1 Wind data sub-tab

The **WIND DATA** sub-tab tab displays real-time wind speed, radial wind speed and speed dispersion.

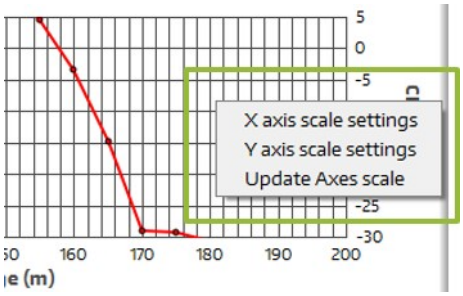


- Red color represents the positive radial wind speed.
- Blue color represents a negative radial wind speed.
- This convention cannot be changed.

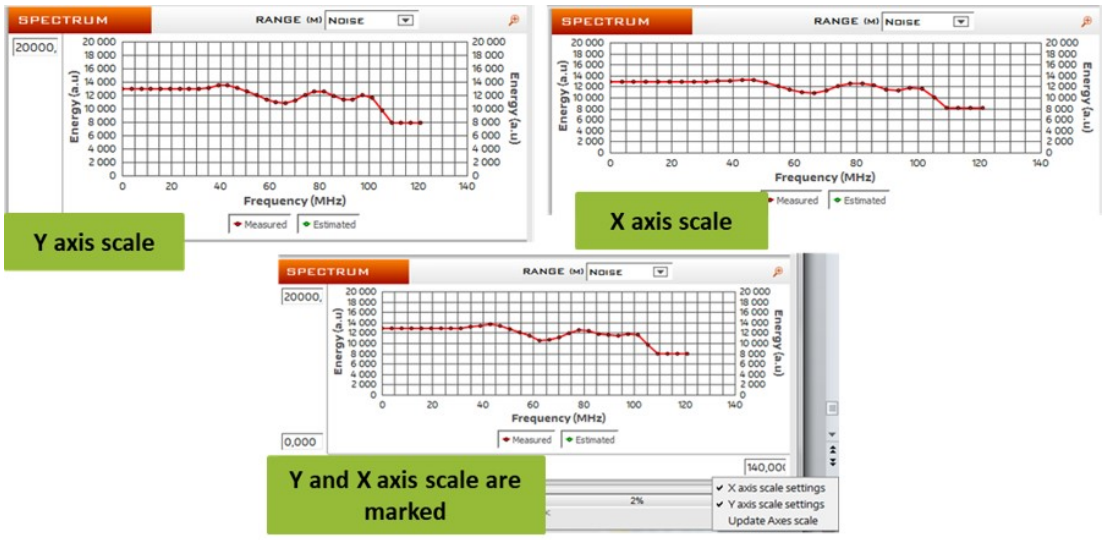
5.2.1.1 Adapting the scale

To adapt the scale:

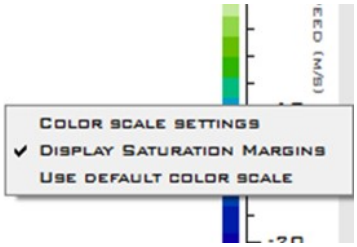
1. Use a right click on the graph.
2. Adapt the scale along the vertical, horizontal axis or both:
   - **X axis scale settings**:
   - **Y axis scale settings**:
   - **Update axes scale**: Adapt automatically the scale.



3. Double-click on the scales axis to center the signal, if the scale is not appropriate.



4. Right-click on the scales, to adjust the scales of each graph The user would be able to access the scales settings.



5.2.2 Aerosol/cloud sub-tab

The **AEROSOL/CLOUD** sub-tab displays information about detected layers of clouds and aerosols.

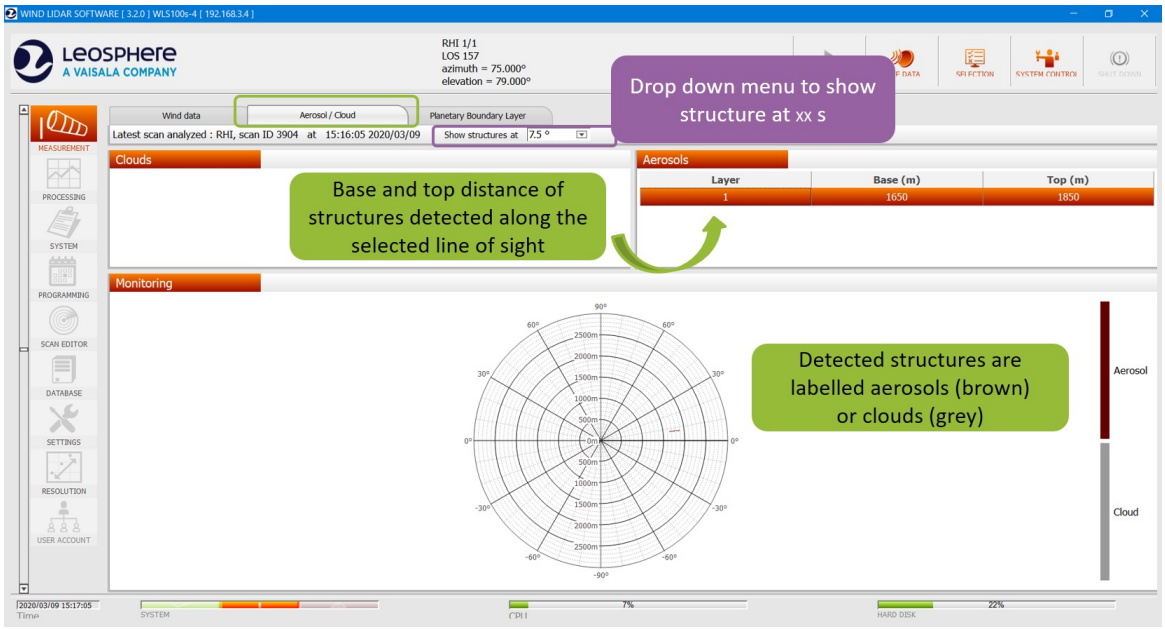
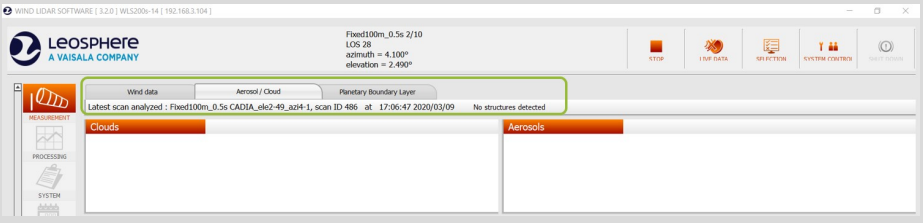


Figure 23 **AEROSOL/CLOUD sub-tab**

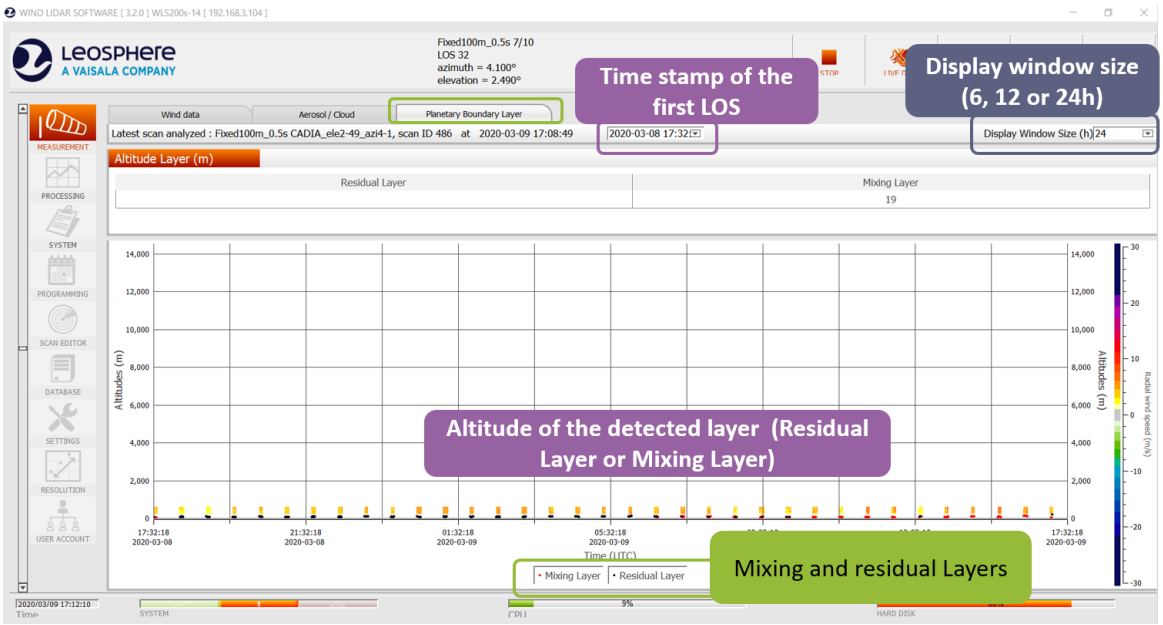
Note that for **FIXED** scan, on the abscissa of the graph, the start of the scan with the oldest data is on the left side and the end of the scan is on the right side (at point 0).

A message is displayed to indicate whether structures have been detected or not.



5.2.3 Planetary Boundary Layer sub-tab

The **PLANETARY BOUNDARY LAYER** sub-tab displays information about detected **PBL**.



The user can select the time of **PBL** data displayed among 6h, 12h or 24h.

Mixing and residual layer heights are displayed on a mean radial wind speed 2D graph.

If refresh data display is necessary, change the display window size.

5.3 Processing tab

The **PROCESSING** tab has 1 or 2 sub-tabs which are **Processing**.

HARD TARGET DETECTION functionality is available from expert profile only.

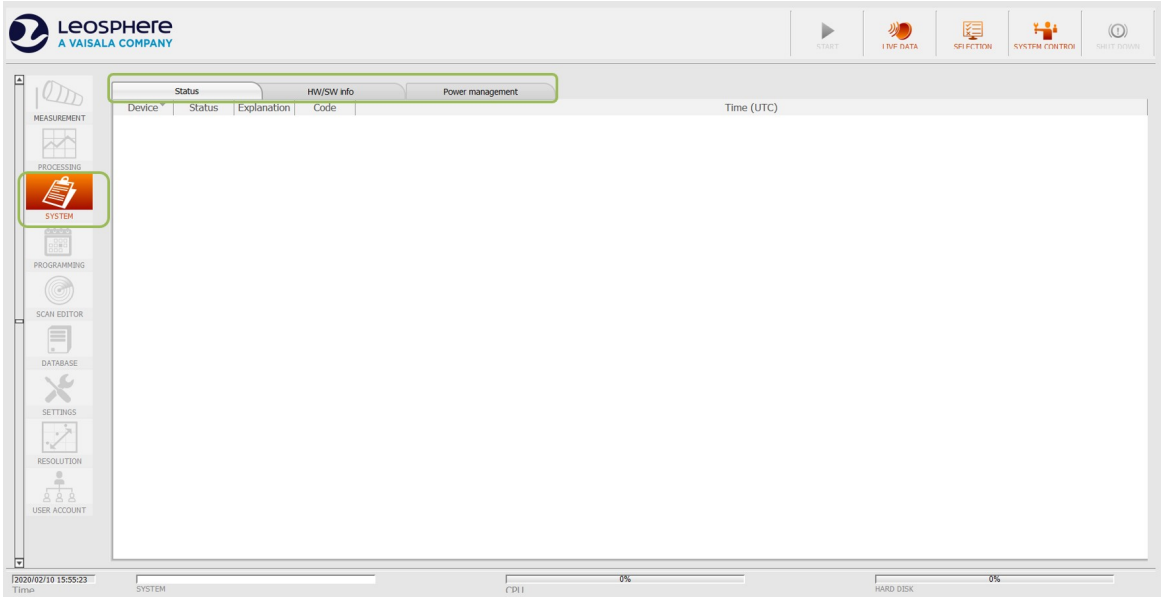
Figure 24 Processing tab and Processing sub-tab

- To zoom and reduce the windows, a magnifying glass icon is represented on the top right of each window 
- **Acquisition** signal: displays the raw (temporal) signal.
- **Spectrum**: displays the Power Spectral Density (PSD) of the detected and estimated signals at defined range gates.
- **CNR** (curve): displays the carrier to noise ratio of the current Line Of Sight.
- **CNR** (2D graph): displays the carrier to noise ratio of the whole scan.

- In case of beta options, a drop-down menu permits to display curve and 2D graph of **Attenuated Relative Beta** and **Attenuated Absolute Beta** in addition to the **CNR**.

5.4 System tab with status and system info

The system tab is composed of 2 or 3 sub-tabs, depending the user profile.



Status and **HW/SW info** sub-tabs are always visibles.

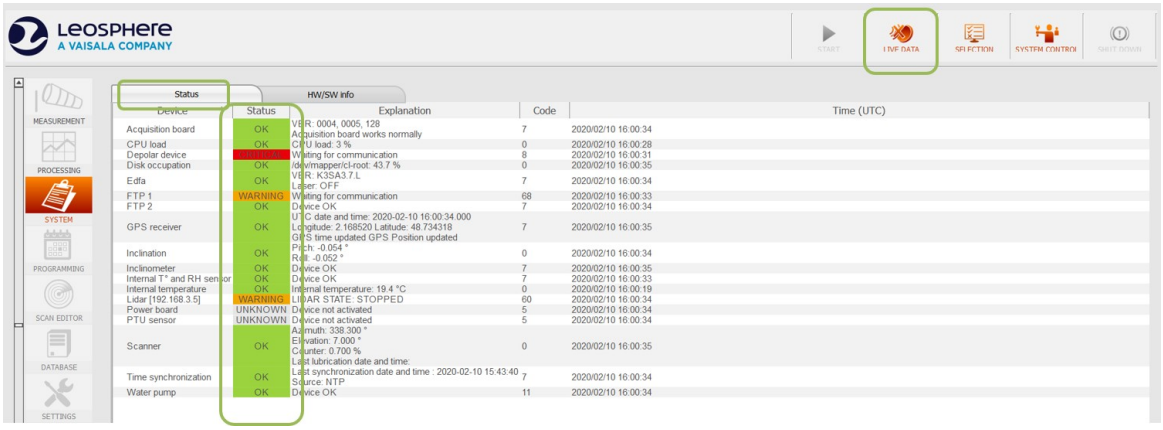
Power management sub-tab displays from the expert profile.

5.4.1 Status sub-tab

From the **System** tab, you can reach the **Status sub-tab**. This last one, displays the status of each subcomponent of the system, and allows a safe monitoring of the LIDAR.

Statuses are displayed only if **LIVE DATA** button is activated and if **Status** is selected in the Selection.

Figure 25 **Status sub-tab**

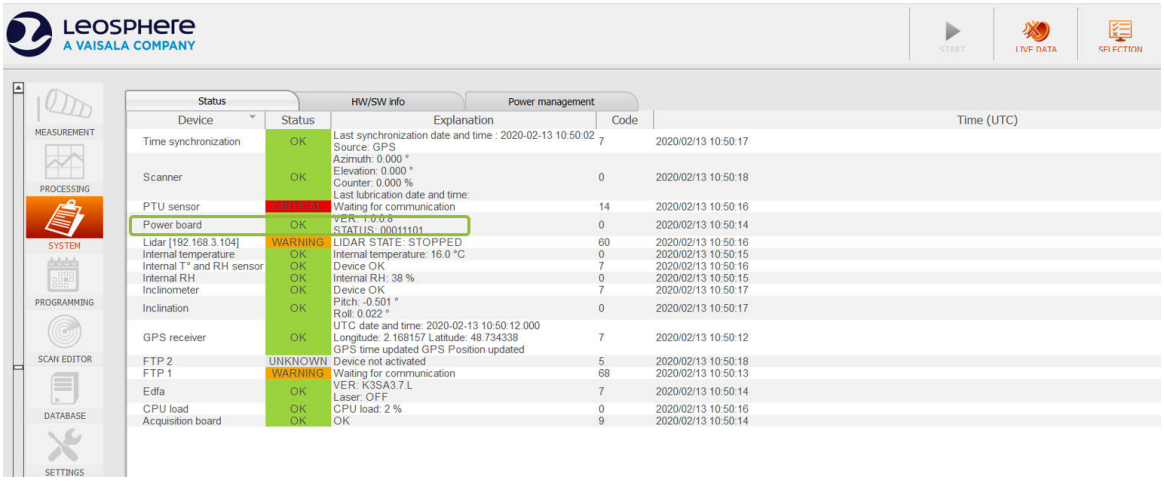


Each change of status is displayed, and real-time updated. There are four types of status which are:

- **OK** (green)
- **WARNING** (orange)
- **CRITICAL** (red)
- **UNKNOWN** (grey)

- Each status change is logged in status files.
- The **CODE** column corresponds to the code to be given to the customer service in case of diagnostic.
- When a device is not activated the status is **UNKNOWN**.
- FTP1 corresponds to a **FTP** customer device and FTP2 corresponds to **FTP** supplier device.

The status of some device is present in the status page only when the device is enabled in the settings, for example, below the power board.



5.4.1.1 Statuses description

Table 16 Statuses and description

OK	• Conform operation of the subcomponent's main function
WARNING	• Abnormal state that does not lead to an immediate failure of subcomponent main function • Subcomponent deactivated (except **FTP**)
CRITICAL	• Failure of the subcomponent main function • Communication loss with the subcomponent

UNKNOWN	• Default status • Device deactivated

A line in **STATUS tab** describes either a subcomponent or its value. In following paragraphs, we use the term *subcomponents* for both.

Each subcomponent status is refreshed every 0.5 to 5 second except 'core disks usage' that is refreshed every 2min.

The following table describes all subcomponents:

Table 17 Subcomponents status description

Status name	Description
Water pump	Wiper pump status
Time synchronization	This status allows to manage more precisely the system's time synchronization configuration and monitor it
Scanner	Scanning head status. The counter reaches 100% every 10000 rounds, and forces the scanning head to reinitiate. This ensures a proper **Calibration** every initialization. While scanner is wiping, the scanning head status switches to **WARNING** for a second. This action is logged in status file.
PTU sensor (optional)	External pressure, temperature and humidity probe status
Lidar system x.x.x. [---.---.---.---]	General status of the LIDAR system with its software version x.x.x. (server) and IP address [---.---.---.---]. Computed from all other statuses.
Internal Temperature	Internal temperature measured by internal T° and RH probe. • 0°C < Internal temperature < 40°C status **OK** • -5°C ≥ Internal temperature ≥ 45°C status **CRITICAL** • In between, status **WARNING**
Internal T° and RH sensor	Internal temperature and relative humidity probe status. Its state can be **OK** (the sensor is connected), **WARNING** (the sensor is not activated), or **CRITICAL** (the sensor status failed).
Internal RH	Internal relative humidity measured by internal T° and RH probe. • 0 ≤ RH < 40% status **OK** • 40% ≤ RH < 80% status **WARNING** • 80% ≤ RH ≤ 100% status **CRITICAL**
Inclinometer	Inclinometer status.
Inclination	Inclination returned by the inclinometer By default: • -2° < Pitch/Roll < 2° status **OK** • -5° ≥ Pitch/Roll ≥ 5° status **CRITICAL** • In between, status **WARNING**
Hard disk	Hard disk status

Status name	Description
GPS Receiver	Internal GPS receiver status
FTP customer	**FTP** status • **OK**: device activated and temp directory contains less files than the “Warning threshold” • **UNKNOWN**: device is not activated • **WARNING**: device activated and temp directory contains more files than " Warning threshold "
Edfa	LASER amplifier status
Disk occupation	Hard drive disk usage • 0 ≤ disk usage < 70% status **OK** • 70% ≤ disk usage <85% status **WARNING** • 85% ≤ disk usage status **CRITICAL**
CPU Load	CPU Load returned by the internal computer • 0 ≤ CPU load < 75% status **OK** • 75% ≤ CPU load <90% status **WARNING** • 90% ≤ CPU load status **CRITICAL**
Acquisition loop	Overall processing time (PT) in ms. It must be lower than the accumulation (A) to ensure a stable behavior of the Lidar • 0 ≤ PT/A < 90% status **OK** • 90% ≤ PT/A <100% status **WARNING** • 100% ≤ PT/A status **CRITICAL**
Acquisition board	Acquisition board status
Disk extraction	• Extraction Successful status **OK** • Extraction started at XXXX-XX-XX XX:XX:XX (X files to extract) status **OK** • Extraction manually interrupted status **OK** • Nothing to extract status **OK** • Extraction error status **CRITICAL** • Extraction is not possible at the moment status **WARNING** *The status "Extraction is not possible at the moment" is indicated when the user did not stop the acquisition before starting the extraction.You must then stop the scan and restart the extraction.* • Waiting for communication status **WARNING** *This status appears when there are too many files waiting in the server side directory which may indicate a **FTP** connection problem. In this case, stoping the acquisition may be a bit slow to be taken into account (5 seconds which is the timeout time to send an **FTP** file).*

Status name	Description
Power Board	 The switch state of the pump/scanner and the acquisition board are displayed with the STATUS field: Bit 0 SCAN Bit 1 PUMP Bit 2 acquisition board Bit 3 not affected Bit 4 not affected Bit 5 not affected Bit 6 not affected Bit 7 not affected *Example*: a STATUS = 000011101 indicates that the scanner and acquisition board are powered, a STATUS = 000011001 indicates that the acquisition board is not powered. The firmware version of the device is indicated in the “VER:” field

5.4.1.2 System status

A general system status is computed, every 5 seconds, according to the state of all subcomponents described in the previous section. If all subcomponents are **OK**, the general status is **OK**. Otherwise, the following table gives the general status according to subcomponent status:

	If the subcomponent status is in ... then global status is	WARNING	CRITICAL	UNKNOWN
Subcomponents	Acquisition loop	WARNING	WARNING	WARNING
	Acquisition Board	OK	CRITICAL	WARNING
	EDFA	WARNING	CRITICAL	WARNING
	Scanner	WARNING	CRITICAL	WARNING
	GPS Receiver	OK	WARNING	WARNING
	Inclinometer	WARNING	WARNING	WARNING
	Hard disk	WARNING	not used	WARNING
	Internal T° et RH sensor	WARNING	WARNING	WARNING
	PTU sensor	WARNING	WARNING	WARNING
	Water Pump	WARNING	WARNING	WARNING
	CPU load	WARNING	CRITICAL	WARNING
	Disk Occupation	WARNING	CRITICAL	WARNING
	FTP 1	WARNING	not used	OK
	FTP2	WARNING	not used	OK
	Inclinaison	WARNING	CRITICAL	not used
	Internal RH	WARNING	WARNING	not used
	Internal Temperature	WARNING	CRITICAL	not used
	Time synchronization	WARNING	WARNING	WARNING

- If FTP 1 status is **UNKNOWN** and all the other subcomponent status are **OK**, the Lidar global status will be **OK**.
- If **Acquisition loop** status is **WARNING**, **CRITICAL** or **UNKNOWN** and all the other subcomponent status are **OK**, the Lidar global status will be **WARNING**.
- If **CPU load** status is **CRITICAL** the Lidar global status will be **CRITICAL** whatever the others subcomponent status.

When the Lidar global status is **OK** or **WARNING**:

→ Measurement can start.

- If the **Autorun** is activated, measurements automatically start once the system is on.

In case the Lidar global status becomes **CRITICAL**:

→ Measurement is stopped or cannot start.

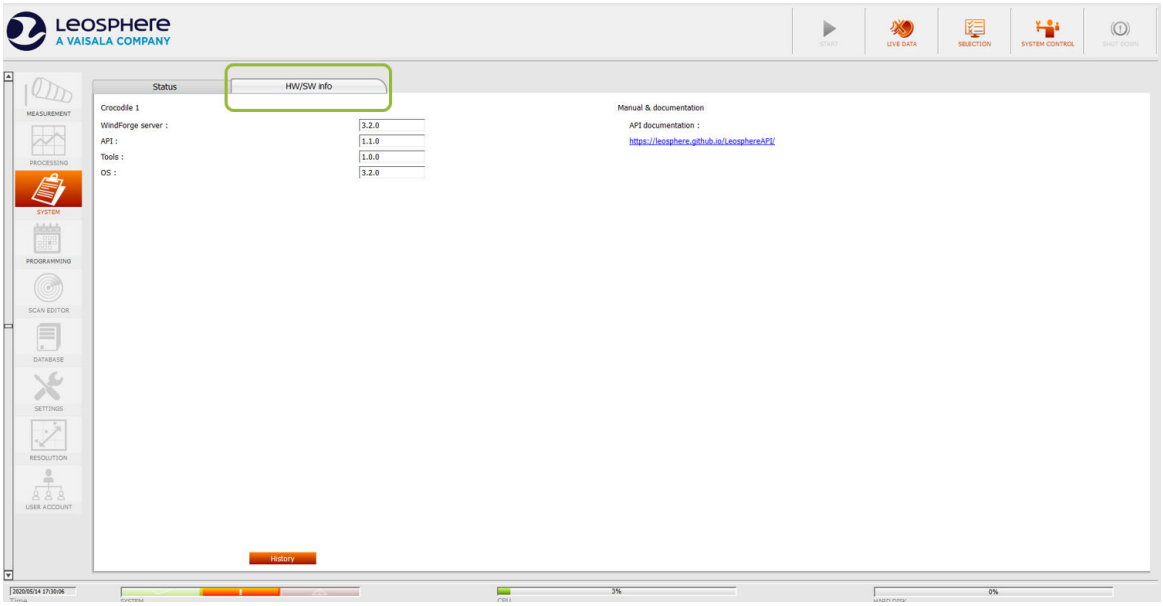
- Some components are automatically turned off until their status comes back to **OK**.

If the Lidar global status comes back to **OK** or **WARNING** after a critical state, it will automatically restart measurements.

5.4.2 HW/SW info sub-tab

From the **System** tab, you can reach the **HW/SW info** sub-tab.

This sub-tab is visible from the Viewer profile.



From **HW/SW info** sub-tab, you can follow the system software configuration (**API** version, WindForge version, tools etc.) which may have to evolve independently in some cases. On the right side, you can also find the link to the **API** documentation.

At the bottom of the screen, the **History button** allows you to download into a zipped file, the software package versions history.

The **History button** is visible only from expert profile.

5.4.2.1 How to download history files

From **system tab > HS/SW info** tab and sub-tab you can download the history file.

1. Click on **History button** The `Select Folder To Export File` displays.
2. Select a folder in the new window.
3. Click on **Select Folder** button. The file is downloaded zipped with a password protection (the same as for log files). If you need to access to some data of this file, you must send it to Leosphere.
   The data format is: *`YYYY-mm-dd_hh-mm-ss_version_history.csv`*.

5.4.3 Power management sub-tab

The **Power management** sub-tab is visible only if this device **Power Board** has been enabled in the settings. This sub-tab is available only for Expert profile.

Power Board has been implemented to manage the power of several devices which are the scanner, the acquisition card, the pump, which can be used when there is a communication issue.

From the **Power management** page you can manage the power supply of the scanner/ acquisition board device and in the case of the pump, to trigger a water jet.

The color of the buttons reflects the current power status of the components in question.

If the **OFF** button is orange it means that the scanner is powered and that the only possibility you have is to stop it by pressing the **OFF** button.

You can activate or deactivate the component only if the system control is enabled and the Lidar is not acquiring.

When you click on one of the buttons, a pop up opens to confirm the action to be performed, for example:

If the scanner is switched off, it will move to the parking position and it will perform a home when it will be reactivated.

- Each status change is logged in the activity files with the action *DEVICE*_SWITCHED_ON or *DEVICE*_SWITCHED_OFF. Depending on the case, the device is either the scanner, the pump, or the acquisition board.
- A pop-up will display until the scanner is positioned and then the scanner power is stopped. The scanner is repositioned before switching off the power.

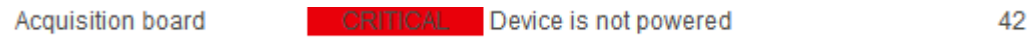
The scanner has then a critical status with the error code 42 "device is not powered".

Scanner	CRITICAL	Device is not powered	42

If the communication with the scanner is switched off, the scanner will not be able to reposition itself to the parking position. However, if the power supply is switched off when the scanner's power is restored, the Lidar server reconnects to the scanner and performs a "home":

No action is possible during this time. The status of the scanner must return to OK as well as bit 0 of the powerboard status.

- When the opto rack is no longer powered, the status of the acquisition board also changes to critical code 42 `device is not powered`.



  Then it returns to an OK state when it is powered:

  In both cases, it is not possible to start the acquisition.
- The pump can be triggered through **Power management** sub tab.
- If the Lidar has been turned off, the card will automatically power all devices at the time of the system startup, regardless the state before the shutdown.

In case that the **Power Board** no longer communicates with Windforge a "watchdog" has been programmed to automatically trigger the re-powering of all devices after 5 minutes.

5.5 Monit

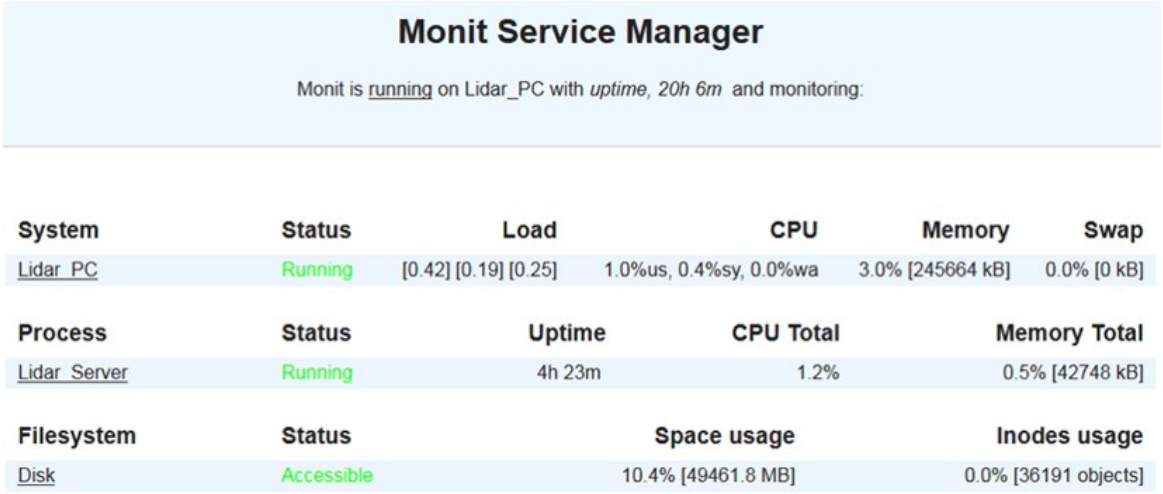
Monit is a small Open Source utility for managing and monitoring UNIX systems. **Monit** conducts automatic maintenance and repair and can execute meaningful causal actions in error situations.

Here it is used to monitor general system resources such as CPU usage, Memory and Load Average on your Lidar PC, Lidar Server and disk.

To connect to **Monit** web-interface, open a web browser and type the following URL: `http://<XXX.XXX.XXX.XXX:45005>`, where `<XXX.XXX.XXX.XXX>` is your Lidar **IP Address**.

CAUTION! Make sure the `port 45005` is open on your network.

Then you have to complete login and password and click on **Connect**. When connection succeeds, the main interface is displayed.

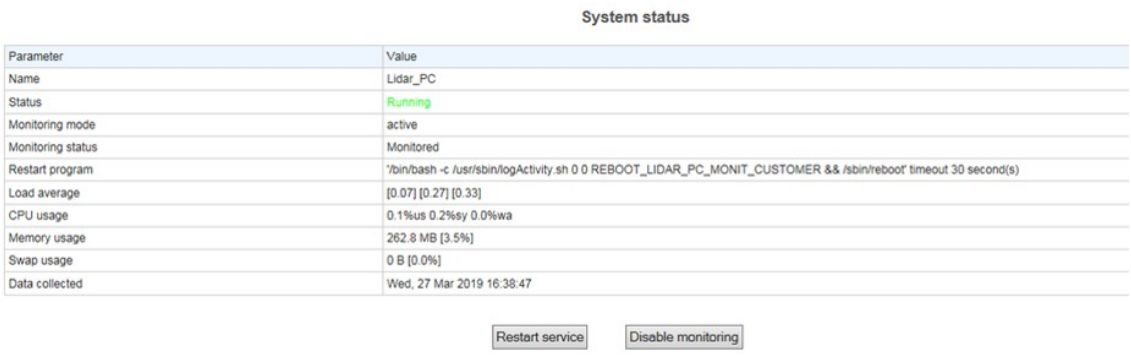


From the web-interface you can start, stop and restart processes and disable or enable monitoring of services.

Table 18 Parameters and functions of each services

PROCESSES/SERVICES	MAIN PARAMETERS MONITORED	FUNCTION
Lidar PC	`Status`, `Load`, `CPU`, `Memory` and `Swap`	Restart Lidar PC Enable/Disable monitoring
Lidar Server	`Status`, `Uptime`, `CPU Total` and `Memory Total`	Start/Stop/Restart Lidar Server Enable/Disable monitoring
Disk	`Status`, `Space Usage`, `Inodes Usage`	Enable/Disable monitoring

For example, you can click on **Lidar Server** to access to its associated functions.



Monit can also start automatically the WindCube Scan software suite in the following cases:

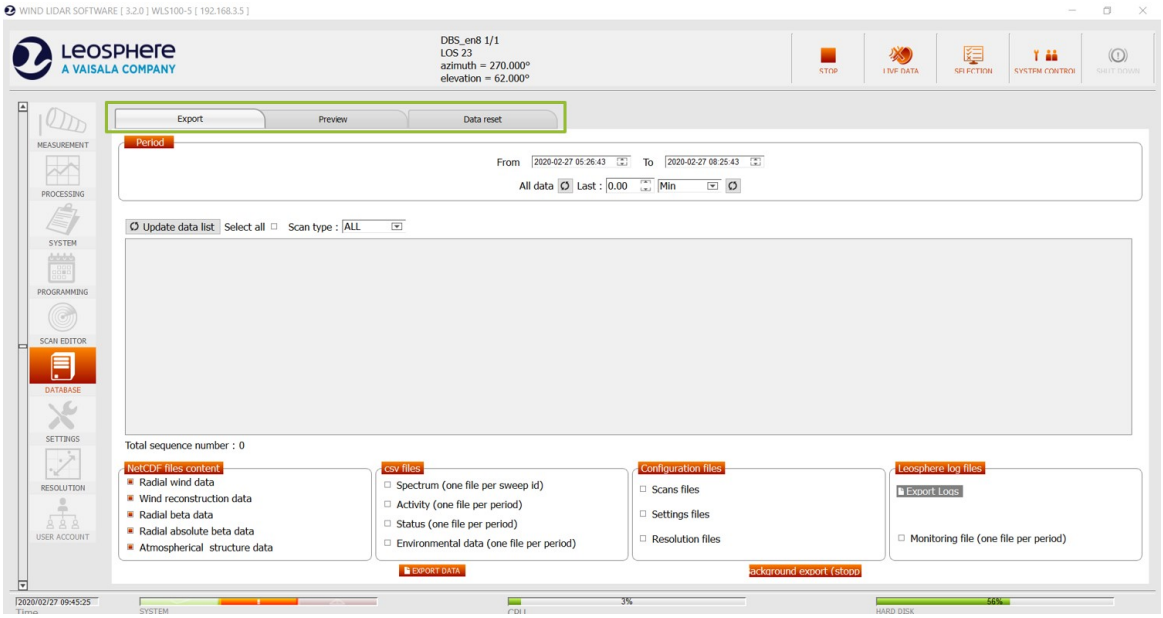
- When your OS starts.
- If the WindCube Scan Software crashes.
- If data acquisition stops.
- If the used memory exceeds 2Go.

- **Monit** does not start the WindCube Scan software when it has been shut down properly via the graphical user interface.
- **Monit** can send you an alert message by email if the WindCube Scan software crashes.
- The **Login** and **Password** for **Monit** is given by Technical Support.

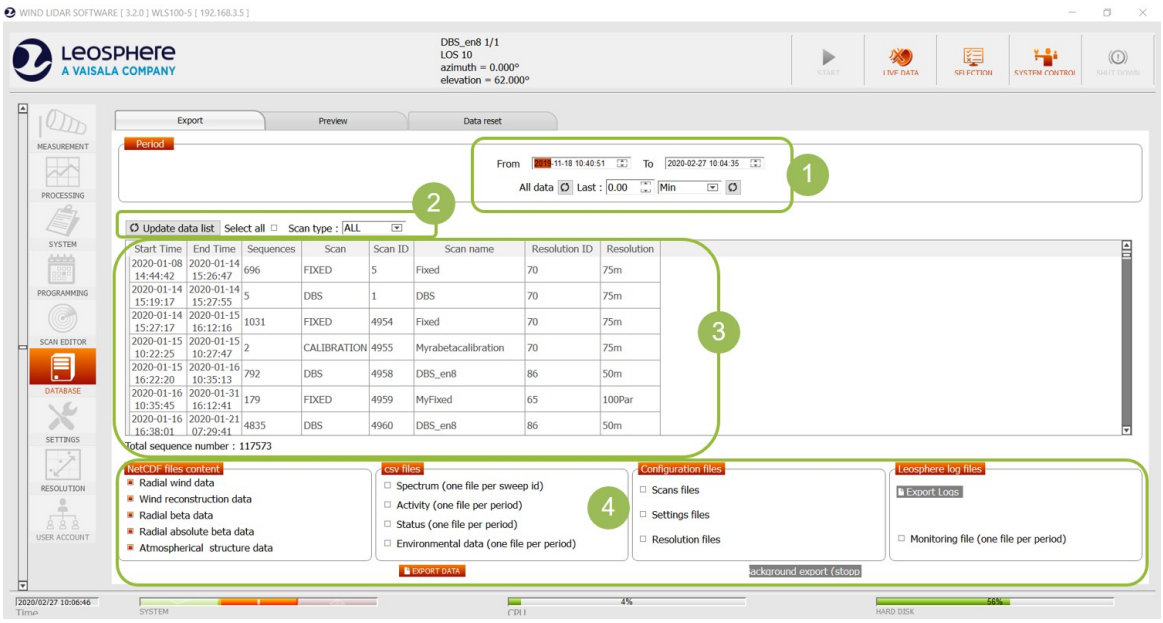
6. Download and manage data

6.1 Data base tab presentation

The **DATABASE** tab has 3 sub-tabs: **Export**, **Preview** and **Data reset**.

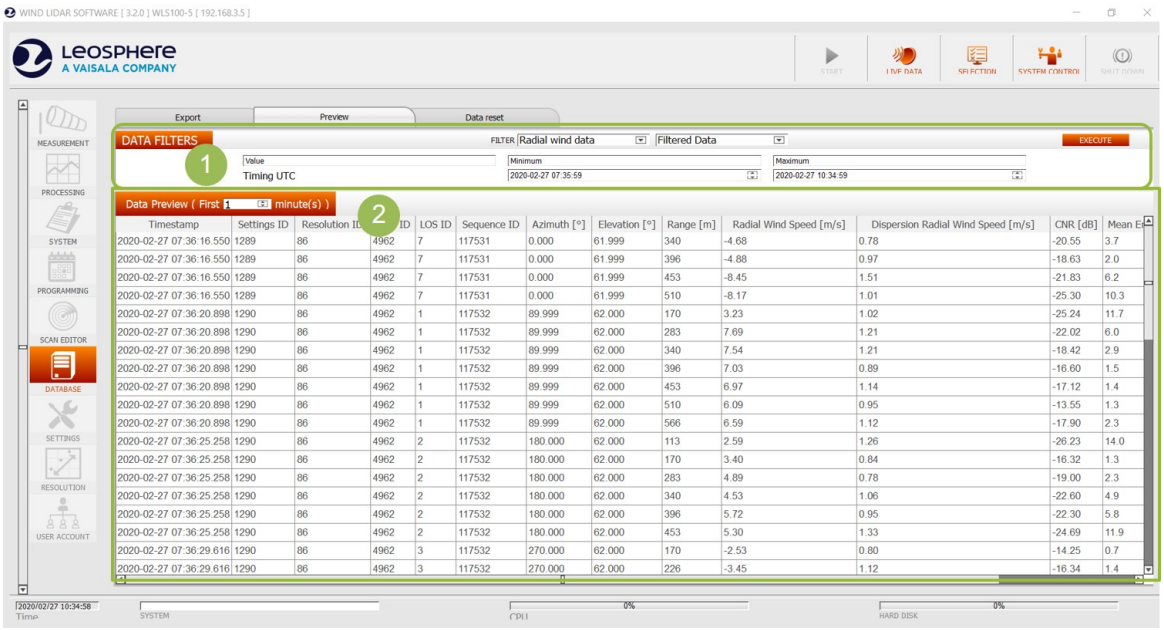


Export sub-tab

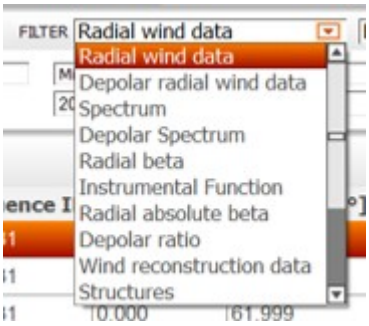


1 Period selection for the export
2 Updating data list and/or filtering
3 Selection of sequences
4 Selection of data types to be exported

Preview sub-tab

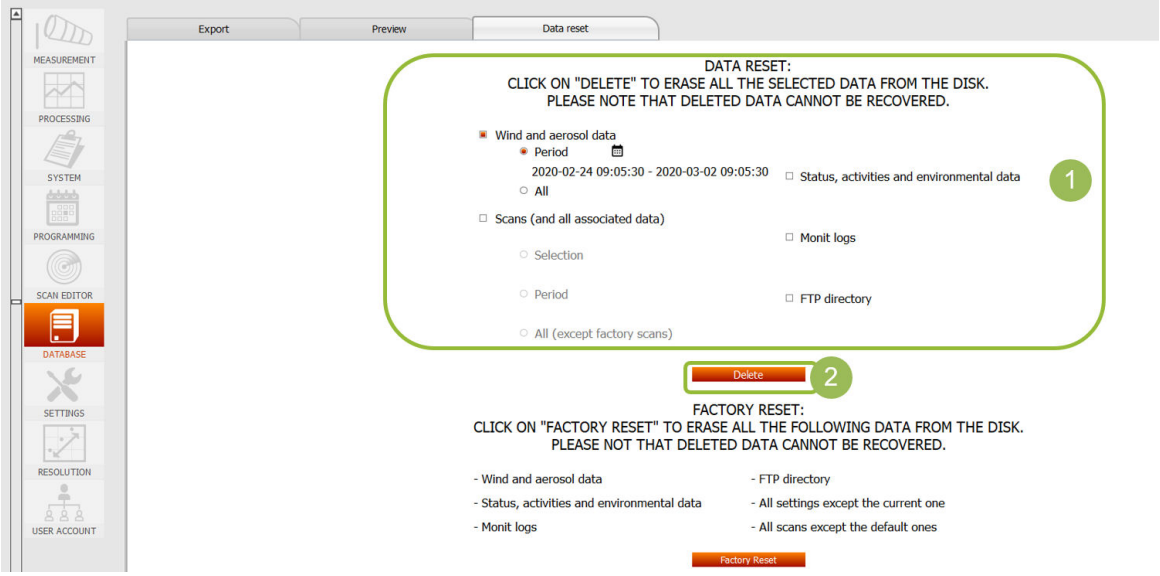


1 Data filters



2 Preview of the filtered data

Data reset sub-tab



1 Data selection
2 **DELETE** button, to erase the selected data

DELETE button and **Factory reset** button are available only when having the system control.

CAUTION! In case of deletion of some scans, all related data will be deleted with.

6.2 Exporting data

The user can download data through different methods:

- Manual export: the user can download manually data from the GUI, and from **DATABASE** tab.
- **FTP** (File Transfer Protocol): the user can manage automatic data sending to a server. In case of this method, don't forget to configure your export from the **SETTINGS** tab and **Disk extraction**.
- **API**: the user can download data through a REST API.

For all scans, one sequence = one scan iteration in **PROGRAMMING** tab. Data are exported by sequence, meaning that one file is created for each sequence.

It is possible to export Netcdf files correctly only when the number of **LOS** expected per sequence multiplied by the number of doors is less to 2 billion.

The first and the last files can begin before or finish after the dates selected by the user, according to sequences beginning and end actual dates.

In the GUI, from **DATABASE** tab, the user can export the same data as by **FTP**:

- Wind and aerosol data (**NetCDF** format),
- **CSV** format spectrum (as option),
- Meta data: `.(x)scan /.(x)set /res` files and environmental and activity status files that are in **CSV** format.

In **Meta data selection** part, if **Scan files** / **Settings files** or **Resolution files** are checked, the files associated with the selected wind & aerosol data will be exported.

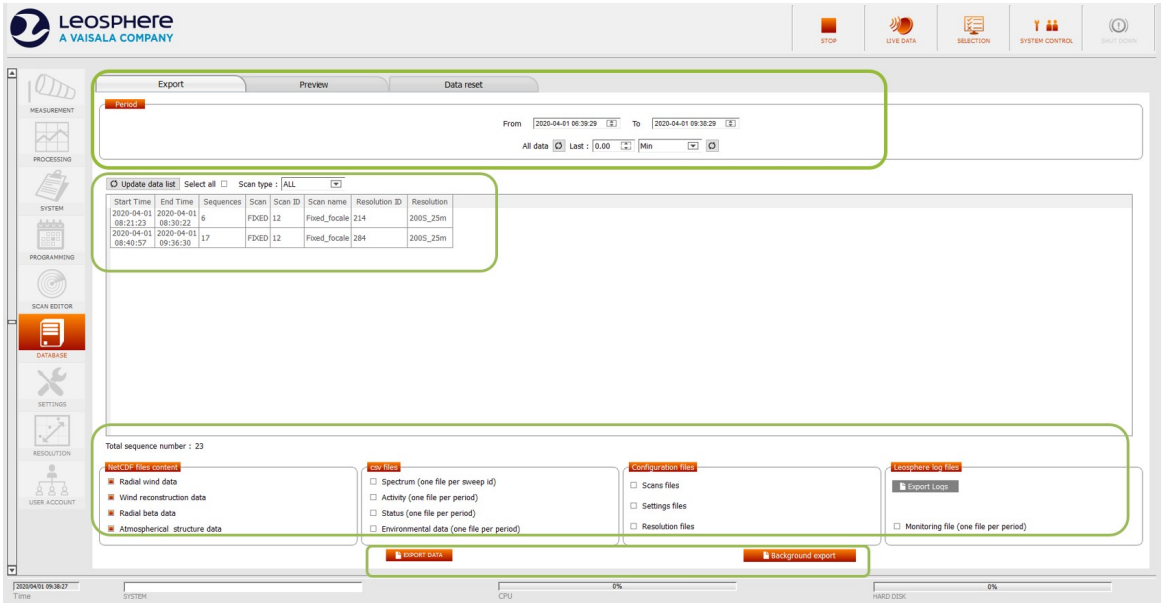
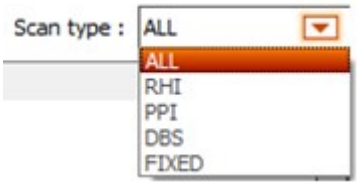


Figure 26 Exporting data

To export data:

1. Go to **DATABASE** tab.
2. Select **EXPORT** sub-tab.
3. Select a **PERIOD** and scheduled range with using **`from`** and **`to`** fields. For the export period, you can choose the export period manually, or by selecting all data, or by choosing the last X hours/minutes/days. Your choices must be validated by pressing the **`refesh button`** icon to update the *`from`* and *`to`*.

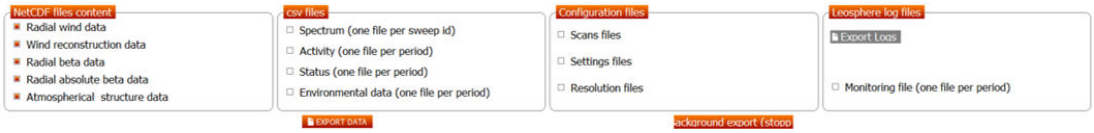
4. Select, if needed, a type of scan using the filter and the drop-down list above the table.



Once the period is selected, click on update data list to update the table of available sequences. Sequences are grouped by scan/resolution association.

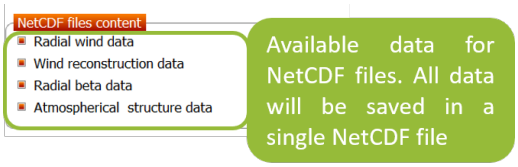
5. Select one or more rows to export.
6. Select the type of data to be exported over these periods. The data have been separated into 4 categories.

The export with the **FTP**, via the Graphical User Interface, only takes into account **NetCDF** files.



- Leosphere log files part and Monitoring file are not visible for the standard profile.
- The log export is done on the selected range (from/to) to avoid that it lasts too long.
- The Monitoring file when checked, allows you to export a **CSV** file that groups activities, Environmental data (including the powerboard averaged data) and status into a single zipped file protected by a **Password**. This check box is only accessible from the expert profile.

7. Select the type of data to export, in the **NetCDF** files content column.
   For an export of **NetCDF** files, by default all data types that can be present in a **NetCDF** file are checked and we recommend leaving it like this in order to have always the same variables.



   For more details on the variables in the **NetCDF** files, please refer to NetCDF file format (page 128).
   If you check **Spectrum** a spectrum file will be created in addition to the **NetCDF** file.
   In case only **Wind reconstruction data** is checked and a **PPI** is played, there will be no **PPI** file exported.

8. Select the Meta data. These data will be exported in addition to **NetCDF** files.

- The full content of *.scan .set* and *.res* is integrated in **NetCDF** files even if Scans files, Settings files and **Resolutions files** are not checked.
- **NetCDF** data, spectra and file configuration are exported according to the selected lines. For activity/status/environmental data they are exported over the entire selected period.

9. Click on **Export Data** button.

10. Select a folder in the window **Select Folder** and then a pop up opens and indicates the progress of the export. The choice of your directory will be kept in memory for a future export.

- All date and time are in UTC time.
- Use the **Preview** tab to preview the data if needed before export.
- Choose a low figure (1 min by default), the lower this figure is, the faster the display will be.

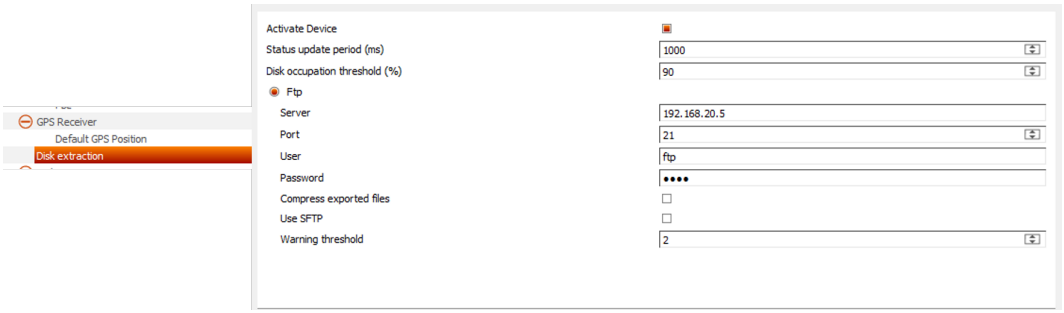
- Data preview begins at the selected date, not when data has been measured. For instance, if you write “1” min in the field **Data preview**, and if there are no data between the minimum date + 1 min, nothing will be displayed.

In case of export with **FTP**, with the Graphical user interface, files are extracted in one archive per day. For this reason, it's necessary to set relative low warning threshold. In this directory, the data will be zipped.
Even in case of network failure, the archive will be sent (there are attempts to send every minute to complete the extraction).
Be careful, if the files already exist in the target directory they must be deleted, otherwise they will be recreated on the server side but not sent, what will fill the disk.

Case of **FTP** export

a. In case of an **FTP** export, you have to configure the export and the **FTP**. To do so:

b. Go to **SETTINGS** tab and **Disk extraction**.



The configuration of this device is the same as for ftp device. A *Disk occupation threshold(%)* field defines the percentage of disk occupancy from which the extraction would stop in case it was reached.
This device is monitored by a status.

a. In case of **FTP** export, you can click on **Background export** button.

The **Background export** button is available only when system control is enabled.This button also indicates the export status, in case live data is enabled.

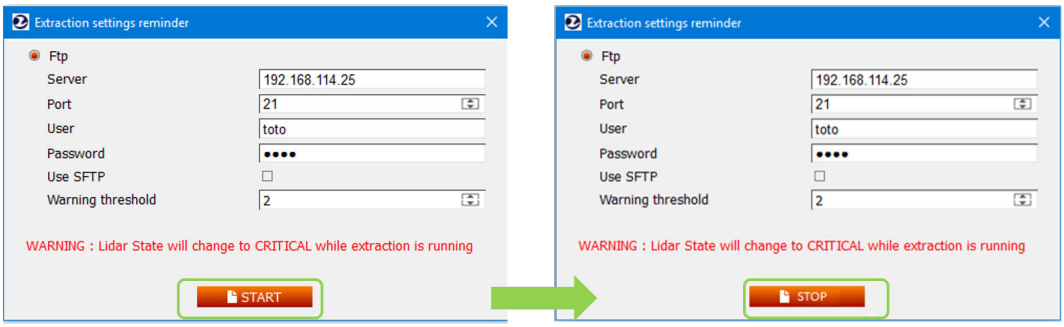
Table 19 Background export buttons

Buttons	Meaning
	Button status without live data enabled
	Button with live data enabled and export in progress
	Button with live data and extraction stopped

When clicking on the button **Background export** the window `Extraction settings reminder` opens. The window displays the configuration of the **FTP** dedicated to the extraction.

It is imperative that the scan be stopped before starting an extraction.

Once the extraction is started the **START** button becomes a **STOP** button.



- The status of the Lidar becomes **CRITICAL** when the extraction starts and remains so until the extraction is completed.
- In this case, you can no longer start the acquisition until the extraction is completed. If you shut down this reminder window and the GUI, this will not interrupt the extraction.
- The extraction will be stopped in the following error cases: the **API** no longer responds, the disk is full and in any case has a critical error. The device's status will remain **CRITICAL** until the next extraction is started.

More information

‣ WindCube Scan API (page 12)

6.2.1 Template for NetCDF file

NetCDF files are named according to the following template:

`SN_YYYY-MM-DD_hh-mm-ss_typeScan_ScanID_ResolutionName.nc`

Example:

`WLS400s-7_2019-01-03_08-45-09_calibration_68_150m400S.nc`

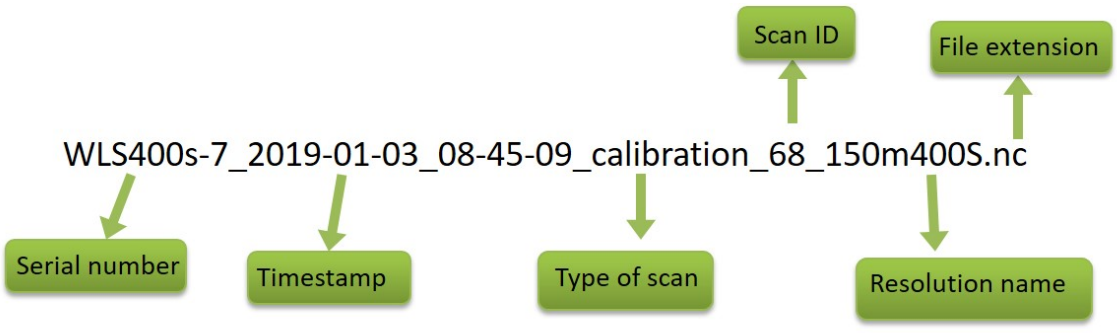


Figure 27 Template for NetCDF file

Table 20 Headers description for NetCDF file

Header	Description
Serial number	Serial number WLSX00s –xxx
Timestamp YYYY-MM-DD_hh-mm-ss	The timestamp in UTC corresponds to the beginning of the period included in the file
Type of scan	**PPI**, **RHI**, **DBS**, **FIXED**, **Calibration**
ScanID	Identifier of the scan used to perform the measurement
Resolution name	**resolution** used to perform the measurement
.nc	**NetCDF** file extension

6.2.2 Exporting logs

These settings are available only for expert profile.

Be careful, do not use this feature without the guidance of Leosphere services.

If you need to export logs from the graphical interface,

1. Go to **Leosphere log files**
2. Click on **EXPORT LOGS** button.
   The button is accessible when the user has the **SYSTEM CONTROL** and the acquisition is stopped.

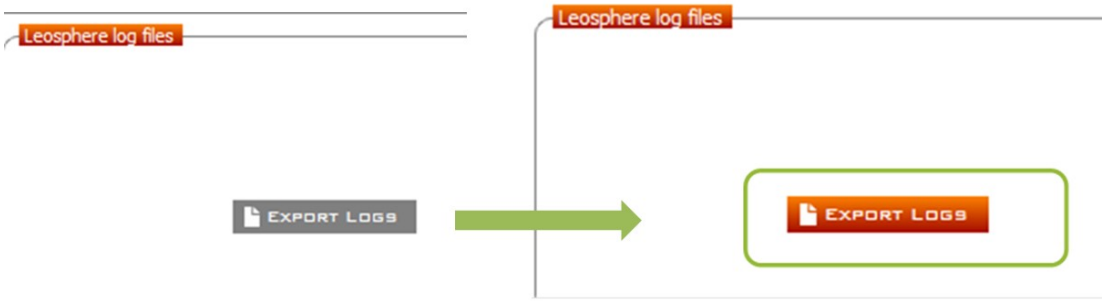
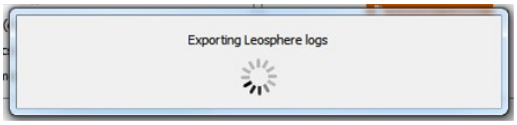


Figure 28 Exporting logs

When pressing the button, a pop up warns that the export can last a long time. Indeed, the generated archive can make several Megabytes even a few Gigabytes. Once the export is launched, a loading pop up of appears and the operation cannot be canceled anymore.



The generated archive is protected by a password, which is the same as that used for the log file exported by the API (these 2 archives are also the same).The archive is named: `logs_SN_YYYY-MM-DD_HH-mm-ss.tar.gz.zip`

Table 21 Headers description for exporting logs

Header	Description
logs	Exported data (log)
SN	Serial Number
Timestamp	UTC YYYY-MM-DD_HH-mm-ss The timestamp corresponds to the beginning of the period included in the file
.tar.gz.zip	Extension of file compression These are archived files with tar and then compressed with gzip

CAUTION! There is a 3 hours timeout on the export of logs. After 3 hours, if the export is not finished, an empty file is created.
In case of a long export, you can use the **API** which has no timeout.

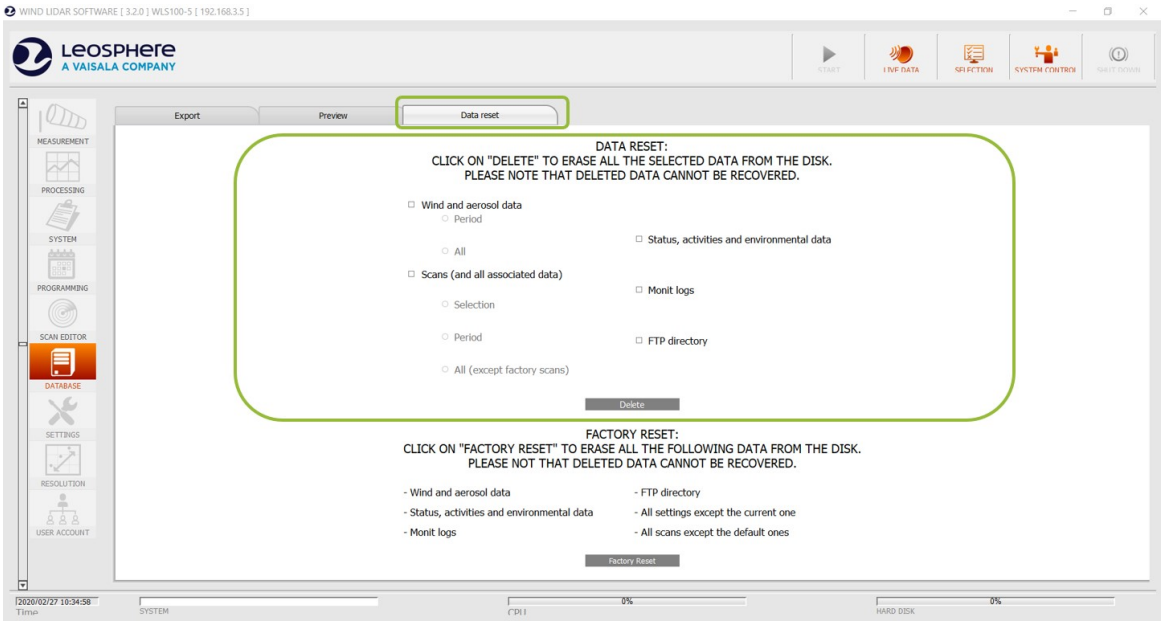
6.3 Reseting data

These settings are available only for expert profile.

Data reset sub-tab erases the wind and aerosol data but keeps settings, resolutions, scans, status, activity and environmental data.

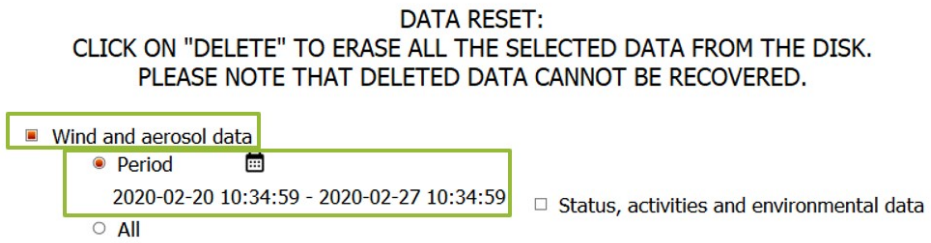
.

CAUTION! Please, make sure to back up your data before reseting the data.
Deleted data cannot be recovered, even by LEOSPHERE.



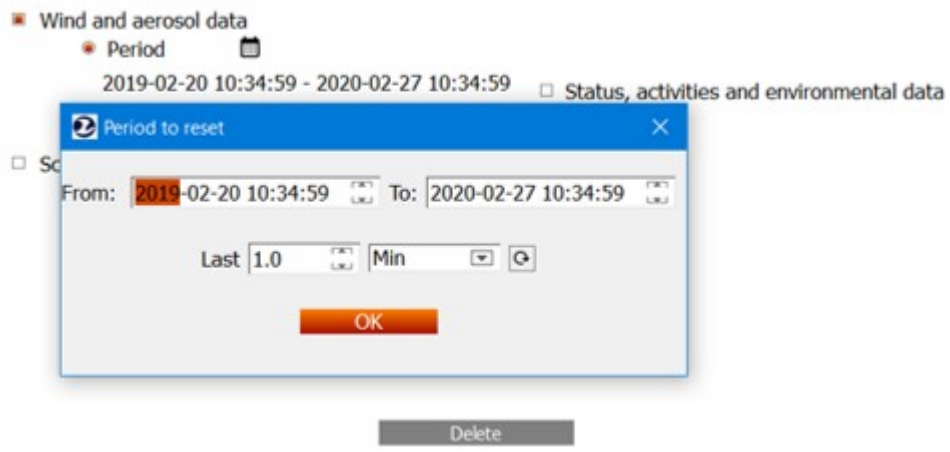
To erase data, the user has to take control of the system by clicking on **SYSTEM CONTROL**, stop the measurements, and then,

1. Go to **DATABASE** tab.
2. Select **Data reset** sub-tab.
3. Choose which data types you want to delete and select a period. You can choose to erase the wind and aerosol data on the entire disk or by selecting a **Period** for this effect:



4. Click on **Wind and aerosol data** check box.

5. Click on **Period** option button and click on the calendar to open it and select your period.

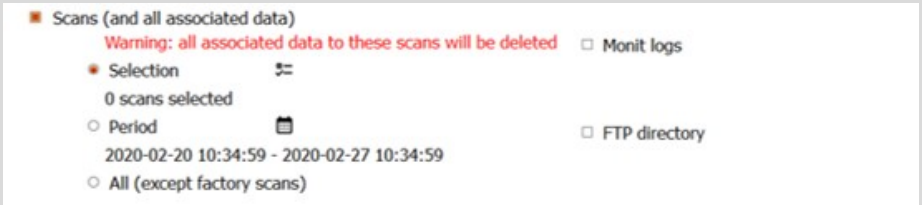


The dates choice can be done either by entering dates manually or by choosing the last X min/hour/day/. In this last case, it is necessary to update the calendar by clicking on the update button. Once validated, the reminder of the selected period is displayed under the **Period** option button. All **Wind and aerosol data** will then be deleted over this period.

You can also choose to delete some **Scans** from the **DATABASE**. To do so,

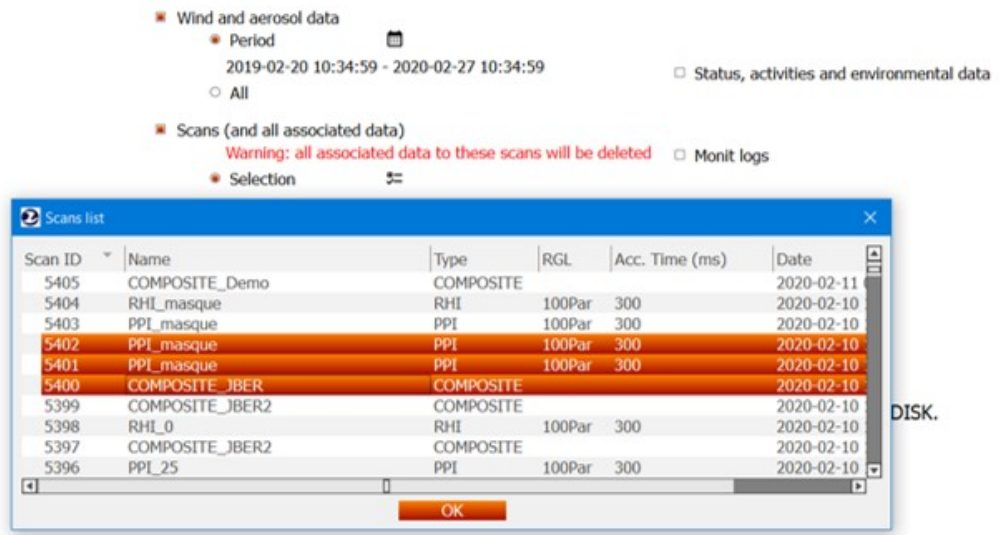
6. Tick **Scans** checkbox.

A warning message will appear underneath to indicate that the deletion of the Scans will necessarily lead to the deletion of the associated data.



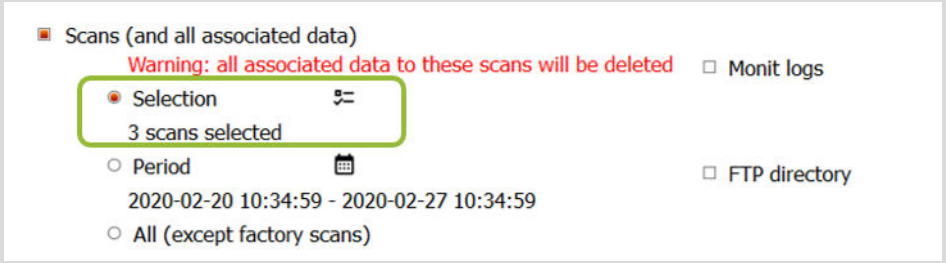
You can also select scans manually. To do so:

7. Click on **Selection** option button and on the icon next to **Selection**.



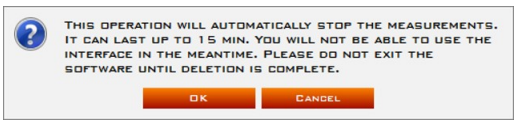
DISK.

The multiple selection is activated in order to choose all scans to be deleted. In this pop-up all scans are displayed. Once validated, the number of scans selected is indicated below the **SELECTION** button.

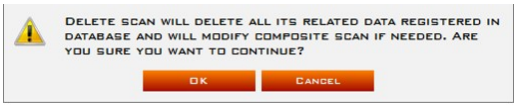


1. You can also select a **Period** for deleting scan. If you choose **Period**, this will erase the scans that were created between these dates.
   Do the same, with the calendar, as described above for **Wind and aerosol data**
   The expert profile can also choose to delete independently or not :
   - Status, activities and environmental data
   - Log archives created by monit that can take up a lot of space
   - **FTP** directory contents
8. Click on **DELETE**. A confirmation window is displayed.

9. Click on **OK** to confirm, or **Cancel** to cancel this operation.
   During the data erasure, the user cannot use the interface.



10. Click on **OK** if you want to continue. A new message displays:



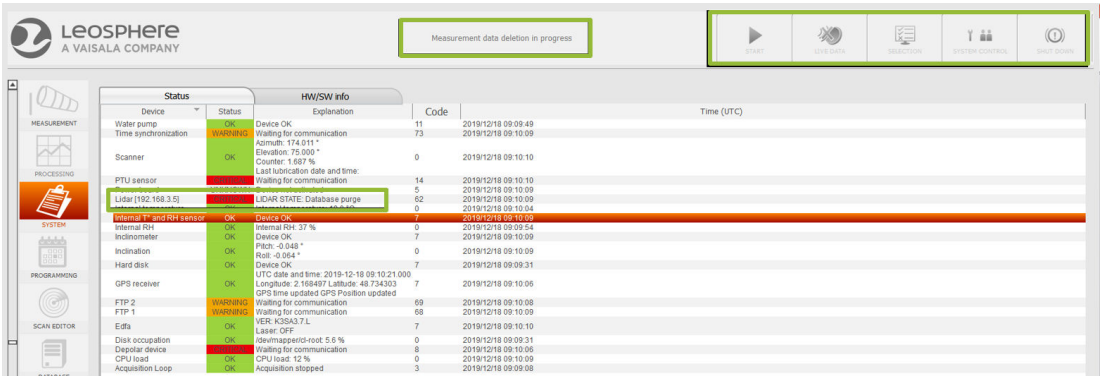
11. Click on **OK** to continue.

CAUTION! If some scans are in the programming and need to be deleted from the programming, this message is displayed:

You can automatically delete all your programming by clicking on **ERASE**, or click on **CANCEL**. In this case the scans must be deleted manually.

CAUTION! Be careful !
If deleted scans are in composites, the**Composite** is deleted and saved again without the concerned scans if they do not have a precursor of the same name. Otherwise they are replaced by scans of the same older name.
If you delete a scan that belongs to a **Composite** and the **Composite** is then without scans, a message will appear when you want to reprogram it:

Once the user has clicked on **ERASE** the LidarServer is in Critical State `Database purge`, the banner displays `Measurement data deletion in progress` and the user cannot take the control or make any action until the purge is completed:



- Once the purge is done, a confirmation message will be displayed to say if the purge is successful or not.

6.4 Wind coordinates generalities

The Wind velocity is defined in the Guide to Meteorological Instruments and Methods of Observation produced by the CIMO from the World Meteorological Organization :*"wind velocity is a three-dimensional vector quantity with small-scale random fluctuations in space and time superimposed upon a larger-scale organized flow"*.

The wind vector can be expressed in a direct cartesian coordinate system (X_E, Y_E, Z_E) standardized in the meteorology standards as indicated in the glossary of the American Meteorology Society:

$$\vec{U} = \begin{pmatrix} u \\ v \\ w \end{pmatrix}$$

Where:

u is known as the zonal wind and is positive toward the East

v is the meridional wind and is positive to the North.

w is the vertical wind speed which is positive for updrafts (ascending wind) and negative for downdrafts (descending wind).

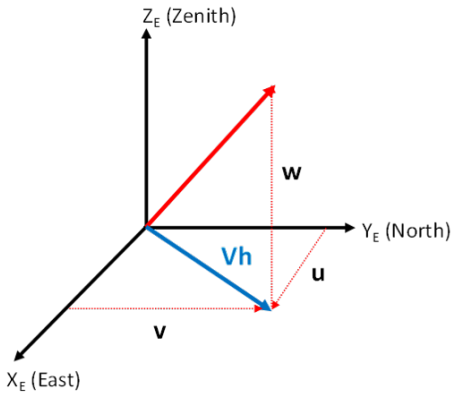


Figure 29 Components of the wind vector in the cartesian coordinate system (x,y,z) used as a standard in meteorology

This {X,Y,Z} frame is named called “Earth frame” in this document.

For many applications, wind is considered mainly as a two-dimensional vector quantity specified by two numbers representing horizontal direction and speed.

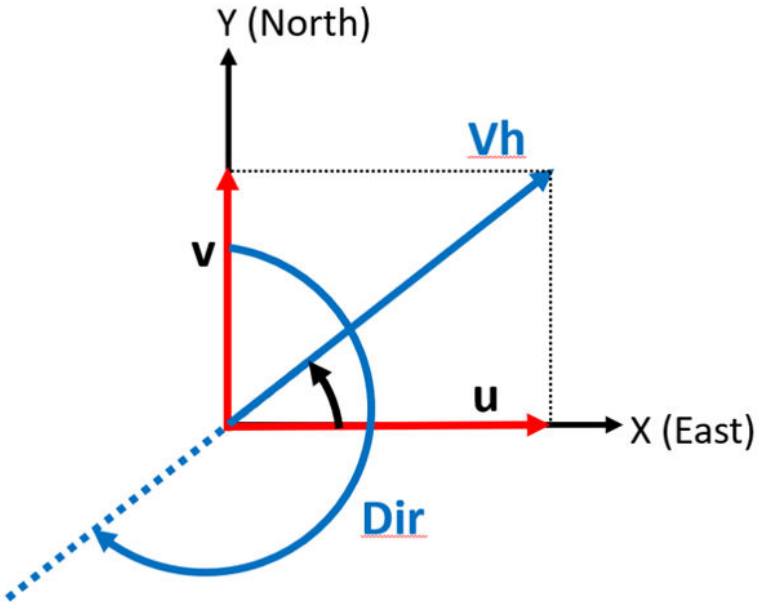
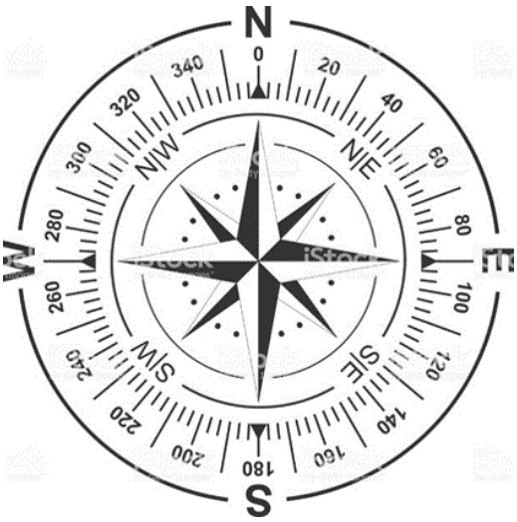


Figure 30 Wind speed and direction in Earth frame

Wind direction is defined as the direction from which the wind blows, and is measured clockwise from geographical north, namely, true north (based on the World Geodetic System 1984 (WGS-84) and its Earth Geodetic Model 1996 (EGM96).



Noted WD for wind direction in this document, the wind direction will be then equal to:

- 0° when the wind is blowing from the North
- 90° when the wind is blowing from the East
- 180° when the wind is blowing from the South
- 270° when the wind is blowing from the West

Horizontal wind speed (**Vh**) and wind direction (**Dir**) can be calculated with the following formula:

$$Vh = \sqrt{u^2 + v^2}$$

$$Dir = mod(270 - atan2(v, u))$$

The atan2 function is defined as follows:

$$\operatorname{atan2}(y, x) = \begin{cases} \arctan\left(\frac{y}{x}\right) & \text{if } x > 0, \\ \frac{\pi}{2} - \arctan\left(\frac{x}{y}\right) & \text{if } y > 0, \\ -\frac{\pi}{2} - \arctan\left(\frac{x}{y}\right) & \text{if } y < 0, \\ \arctan\left(\frac{y}{x}\right) \pm \pi & \text{if } x < 0, \\ \text{undefined} & \text{if } x = 0 \text{ and } y = 0. \end{cases}$$

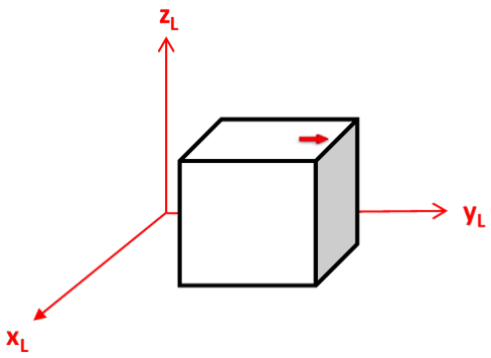
6.5 WindCube coordinate system, related angles and conventions

6.5.1 WindCube frame

The WindCube frame is a cartesian coordinate system which moves with the Lidar. It is defined by:

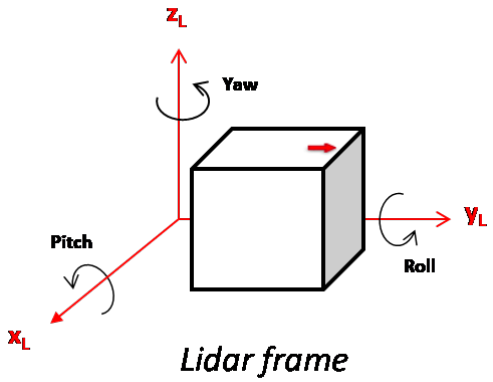
- **y** in the scanning head reference plate, pointing towards the red arrow
- **z** perpendicular to the scanning head reference plate, pointing towards the first mirror
- **x** completes the frame in a right hand direct convention

Figure 31 Windcube frame (x, y, z)



6.5.2 WindCube orientation

The WindCube orientation with respect to Earth frame is defined by:



WindCube Scan must be levelled up and aligned to the North (the red arrow pointing at that direction) so that its frame matches to the standard meteorological frame during Lidar installation. In other word, after installation with α = β = γ = 0° being the pitch, roll and yaw angle. If the Lidar cannot be aligned physically to the North, a software offset can be introduced.

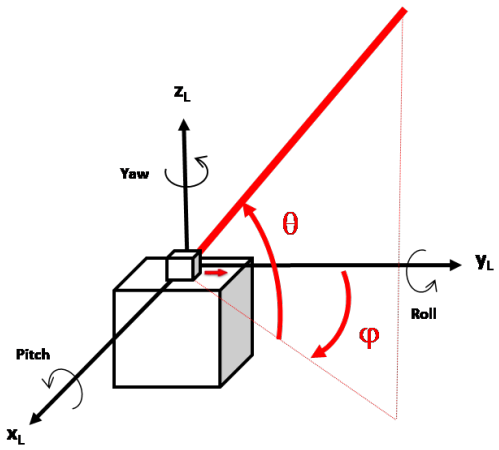
All data are referenced to the meteorological **frame assuming that the Lidar has been properly installed**. If this alignment has not been made properly, the user shall keep in mind that all data are referenced to the Windcube frame.

6.5.3 Azimuth and elevation definition

The **Azimuth** is the angle between the projection of the line of sight on the local

horizontal plane (xy) and the geometric North. This angle is between 0° and 360° with 0° being the North

The **Elevation** is the angle between the line of sight and the local horizontal plane. This angle is between -90° and 90° (-90° is the Nadir, 90° is the Zenith).



6.5.4 Wind speed sign convention

In the standard configuration of the Windcube, radial wind speeds are negative when the wind is coming to the Lidar and positive when the wind goes away from the Lidar.

SignDoppler = 1 when the wind speed coming to the Lidar is negative

SignDoppler = -1 when the wind speed coming to the Lidar is positive

6.6 DBS Algorithm

6.6.1 DBS scan

A vertical profile of the wind vector, can be retrieved by performing a Doppler Beam Swinging scan (**DBS**).

The **DBS** mode consists of 5 lines of sight (**LOS**):

- 1 line of sight in each cardinal direction at a fixed **elevation angle** θ
- 1 vertical line of sight.

The pulsed Lidar principle allows to measure simultaneously several distances in each line of sight. At a given distance, the radial wind speed measured for **LOS** at 0°, 90°, 180°, 270° and zenith are noted respectively: V_0, V_{90}, V_{180}, V_{270}

If the Lidar is well aligned to the Nord: V_0 is the North, V_{90} is the East, V_{180} is the South and V_{270} is the West.

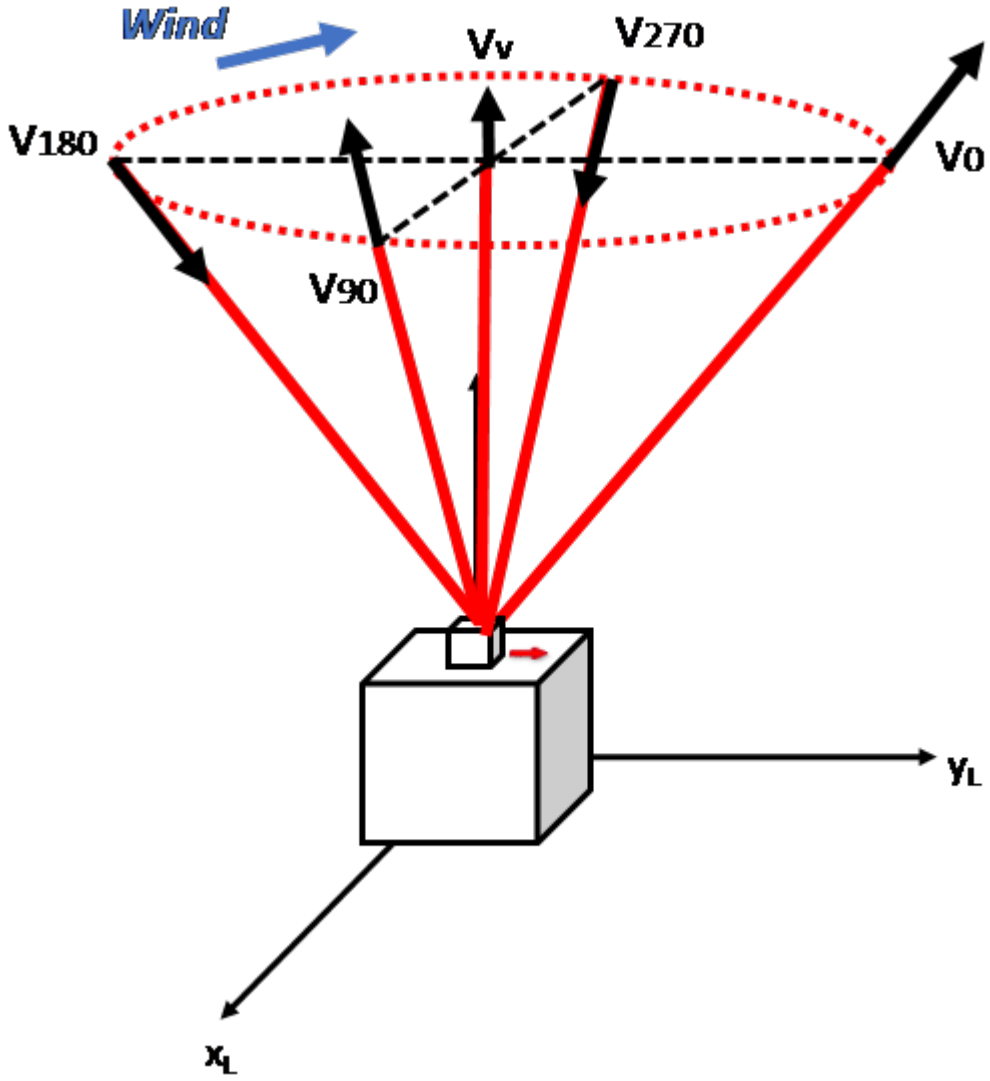


Figure 32 Scheme of the DBS mode

6.6.2 Wind reconstruction

Let's define the "radial wind speed vector", composed by the last four valid radial wind speeds measured (in each cardinal direction):

$$\overrightarrow{Vr} = \begin{pmatrix} V_0 \\ V_{90} \\ V_{180} \\ V_{270} \end{pmatrix}$$

A valid **Radial Wind Speed** is defined as radial wind speed which has been retrieved by the signal processing with a satisfying confidence index. A data is rejected if the confidence index is below a threshold calibrated in factory or when radial wind speed is out of the accepted range.

The determination of the speed vector is $\vec{U}$ given by solving the following equation thanks to a least square method:

$$M * \vec{U} = SignDoppler * \overrightarrow{Vr}$$

Where:

- $$M = \begin{pmatrix} 0 & cos\theta & sin\theta \\ cos\theta & 0 & sin\theta \\ 0 & -cos\theta & sin\theta \\ -cos\theta & 0 & sin\theta \end{pmatrix}$$

- θ is the **elevation angle**

Then, the coordinates (horizontal wind speed Vh and wind direction Dir) are converted within the final coordinates system by:

$$Vh = \sqrt{u^2 + v^2}$$
$$Dir = mod(270 - atan2(v, u))$$
$$w = NaN$$

Vertical wind speed is not determined by this method but directly measured when the **LOS** is vertical:

u = NaN

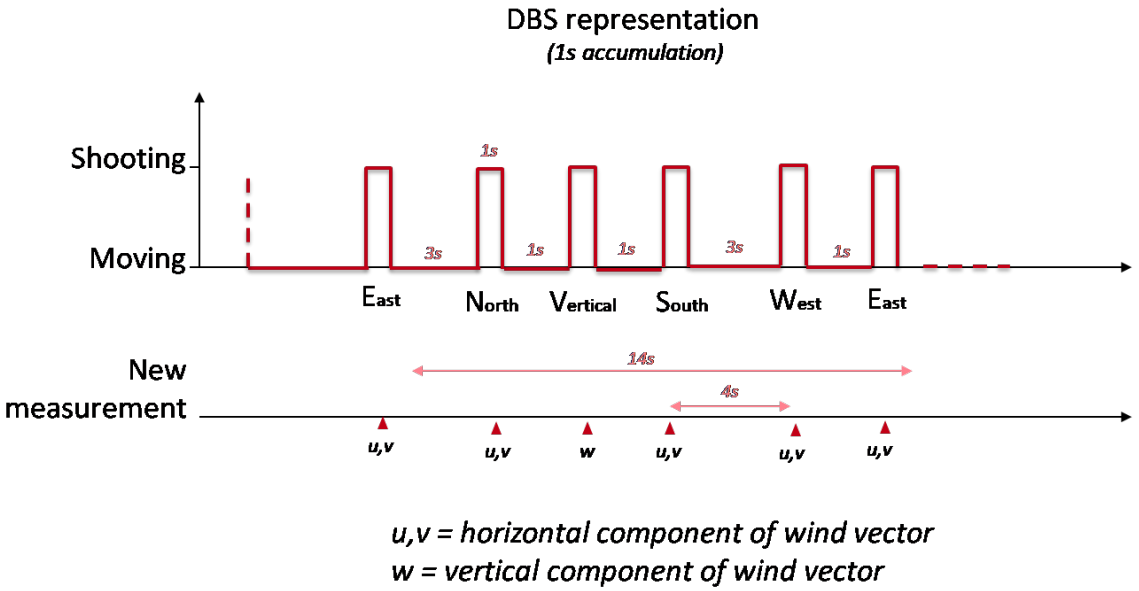
v= NaN

w= signDoppler.V_V

The **Radial Wind Speed** measured along the vertical beam are kept only if they are valid.

6.6.3 Scanning pattern

The **DBS** scan patterns is estimated as follows for 1s of accumulation time:



The wind vectors are given at different measurements:

	u	v	w
North	u_1	v_1	NaN
Vertical	NaN	NaN	w_1
South	u_2	v_2	NaN
West	u_3	v_3	NaN
East	u_4	v_4	NaN

Consequently in this case:

- The time between two consecutive wind speed (horizontal wind speed + direction) reconstruction is of 4s or 2s

- The estimated duration time of the whole scan is 14s

6.7 NetCDF file format

What is NetCDF-4 file format?

Many resources describing the **NetCDF** format are available on Internet. The interested user will easily find more information, especially on the website of UCAR (University Corporation for Atmospheric Research) that maintains the format: http://www.unidata.ucar.edu/software/netcdf/.

NetCDF (Network Common Data Form) is a set of interfaces for array-oriented data access and a freely distributed collection of data access libraries for `C`, `Fortran`, `C++`, `Java`, and other languages. The **NetCDF** libraries support a machine-independent format for representing scientific data. Together, the interfaces, libraries, and format support the creation, access, and sharing of scientific data.

The Leosphere **NetCDF** format is built on **NetCDF-4** which is in turn built on **HDF5**. Consequently, you can use any HDF5 or NetCDF-4 reader to open Leosphere **NetCDF** files. In this user manual, the term **NetCDF** refers to **NetCDF-4**.

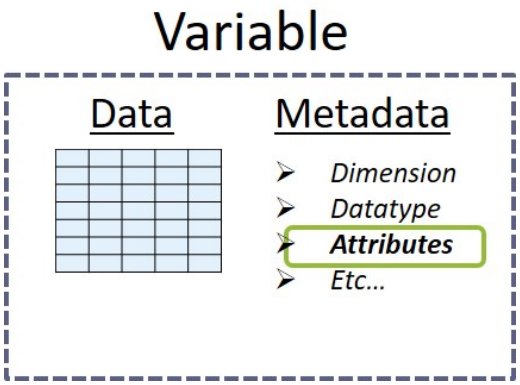
This file format allows grouping all data types (radial, reconstruction, beta, structure, meta-data, etc.) into a single file. This new file format was established using different conventions. These conventions are mentioned in the files. It's an auto-documented format (i.e. it is auto-sufficient and does not require meta-data files).

A **NetCDF** file is made of one or several variables. Each variable is made of:

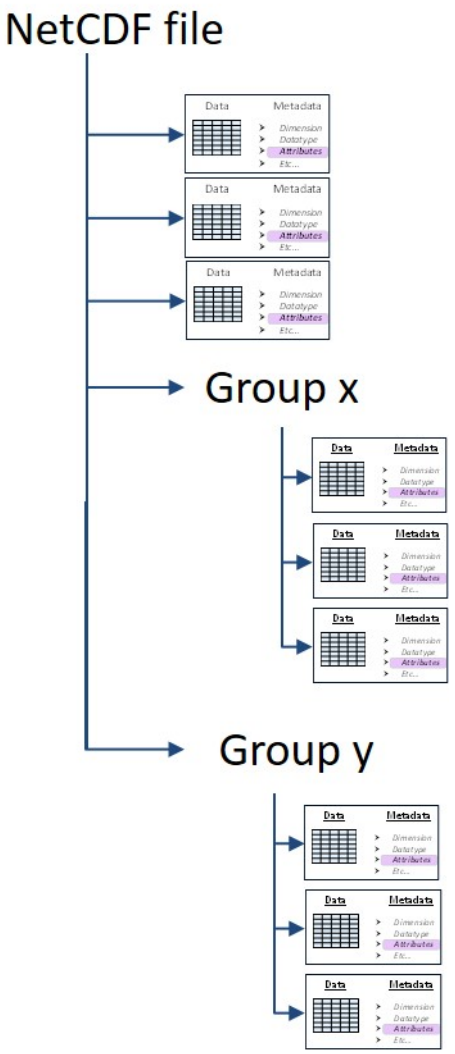
- The data, which is a multidimensional table or a value

- Several metadata that characterize the data.

Figure 33 NetCDF file format

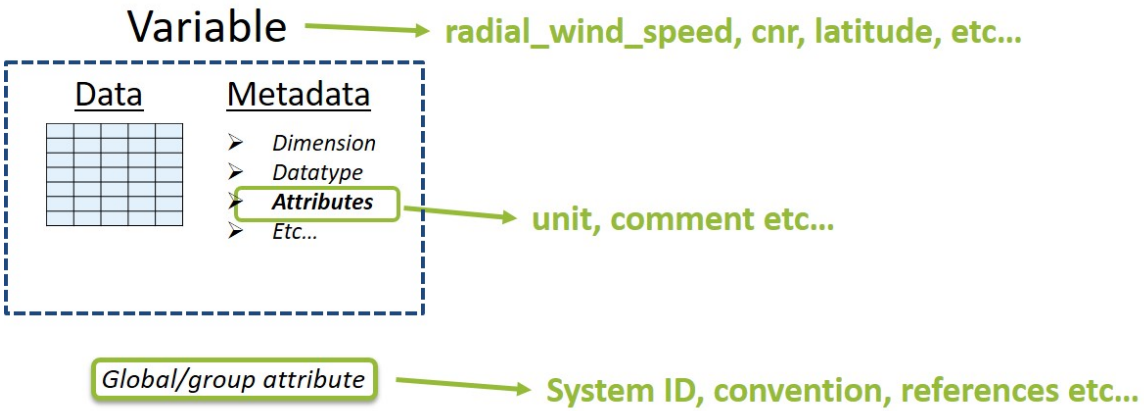


Variables can be organized in a tree structure like below:



But variables are not necessary organized in a tree-structure. If attached at the root level, variables are called “global” variables.

Similarly an attribute is not necessary attached to a variable. In that case, they are called “global” or “group” attributes.



6.7.1 NetCDF conventions

The **NetCDF** format does not define a mandatory architecture. Users can choose any architecture fitting their purpose. However several groups of users introduced proposed conventions to homogenize the content of **NetCDF** files for their community. A list of conventions is given in UCAR website: https://www.unidata.ucar.edu/software/netcdf/conventions.html.

As far as Lidar or RADAR data are concerned, several conventions can be applied.

For instance: Cf Convention, CfRadial2, ODIM_H5 (Opera), HD(CP)^2, WindprofNetCDF. Some are still on development. Generally speaking, conventions are:

- Generic conventions: defining only best practices and principles. The counterpart is that, two files built according to these conventions won’t have the same architecture, even if they share common rules. This is for instance the case of the Cf Convention.
- Dedicated to a project or a sensor (or both): much stricter about the file content. They are in general based on generic conventions (the Cf Convention most of the time). The main advantage is to have a greater homogeneity among the output files. The counter part is that proposed rules, don’t necessary apply to your own system and applications. This is for instance the case of ODIM_H5 (Opera), very radar oriented, HD(CP)^2 or WindprofNetCDF, dedicated to specific observation networks and type of measurements.

The CfRadial2 convention is somewhere in the middle of these two categories: not too generic, but not too rigid and well adapted to Lidar measurements, whatever the application. Consequently, Leosphere chose to base its **NetCDF** files architecture on this convention. Even if very advanced, the CfRadial2 convention is still evolving and being improved. Furthermore some details do not fit to Scanning Windcube data.

Consequently:**Whenever applicable, Leosphere NetCDF architecture is based on CfRadial2 convention otherwise it relies on the Cf Convention**.

6.7.2 Leosphere NetCDF files architecture

As a radar or Lidar scans (or points), the data **fields** (commonly known as 'moments') are computed over limits specified by a time interval or angular interval. This entity is commonly designed as a **ray**, beam, line-of-sight or dwell.

A ray contains a number of **fields**, with a value for each **field** at each **gate**. In the **ray** abstraction, **fields** are represented as 1-D arrays, with length **range**.

In Leosphere **NetCDF** files the term ray is used such that a **ray** = **Line of Sight** (**LOS**).

A **sweep** is a collection of **rays**, for which certain properties remain constant. For a given **ray**, the field's data (or moments) are computed for a sequence of ranges increasing radially away from the instrument. These are referred to as **range gates**.

In the data model adopted by CfRadial2, the **sweeps** contain the field (moments) data directly, stored as 2-D arrays. This requires that the number of gates be constant for all rays in a **sweep**, which is always the case with a Scanning WindCube.

The following *always* remain constant for all **rays** in a **sweep**:

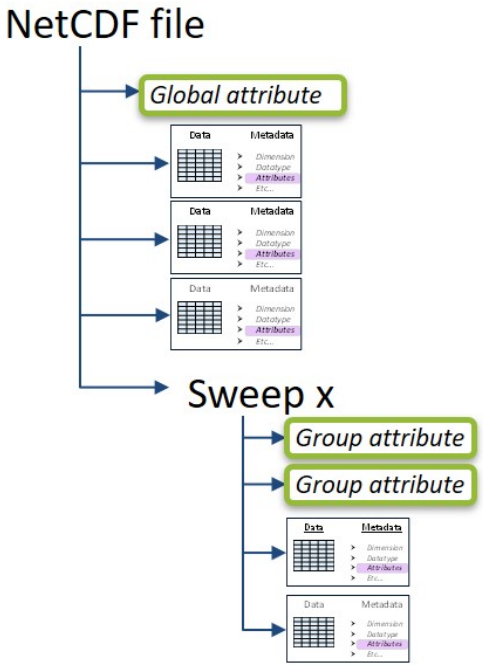
- number of gates
- range geometry (range to each gate)
- **sweep** mode (***PPI***, ***RHI***, etc.)
- target angle(s)

Currently, all Scanning WindCube sequence contains only 1 **sweep**. This could change for instance when volume scans will be introduced.

Here are described only the basics and the specificity of Leosphere **NetCDF** format.

The used convention proposes to classify the files by sequences. For one sequence you have one **NetCDF** file.

The convention uses the term of **sweep**. In this case, a **sweep** corresponds to a sequence and we have 1 **sweep** per scan (for example: 1 **sweep** = 1 **PPI**).



Example of Leosphere NetCDF architecture

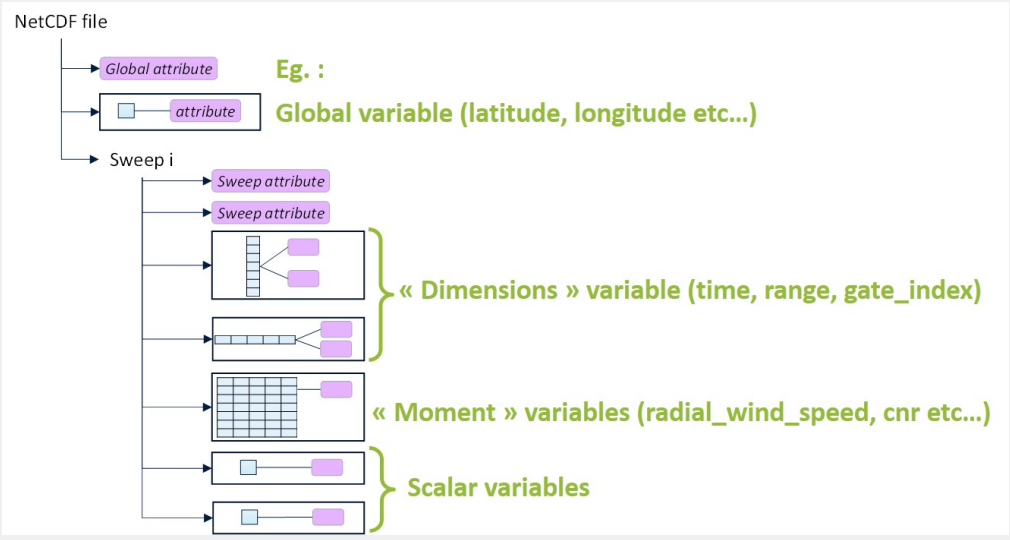
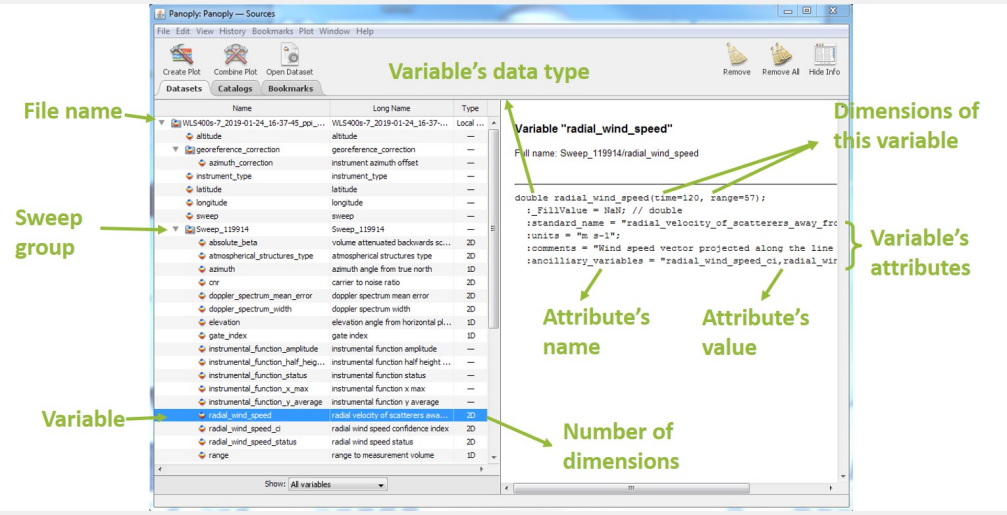


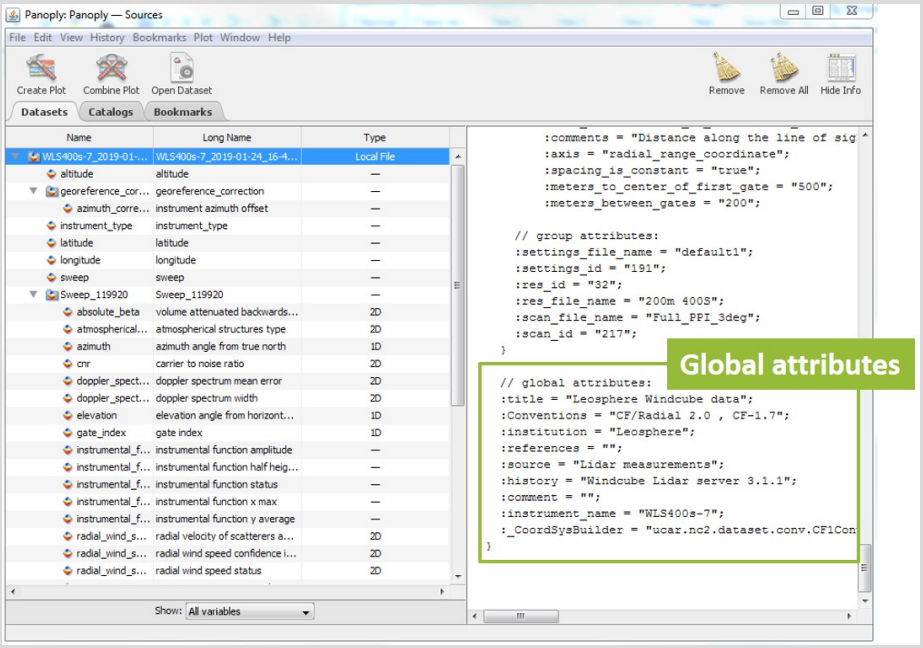
Figure 34 Leosphere NetCDF architecture

Example of a PPI file, opened with Panoply

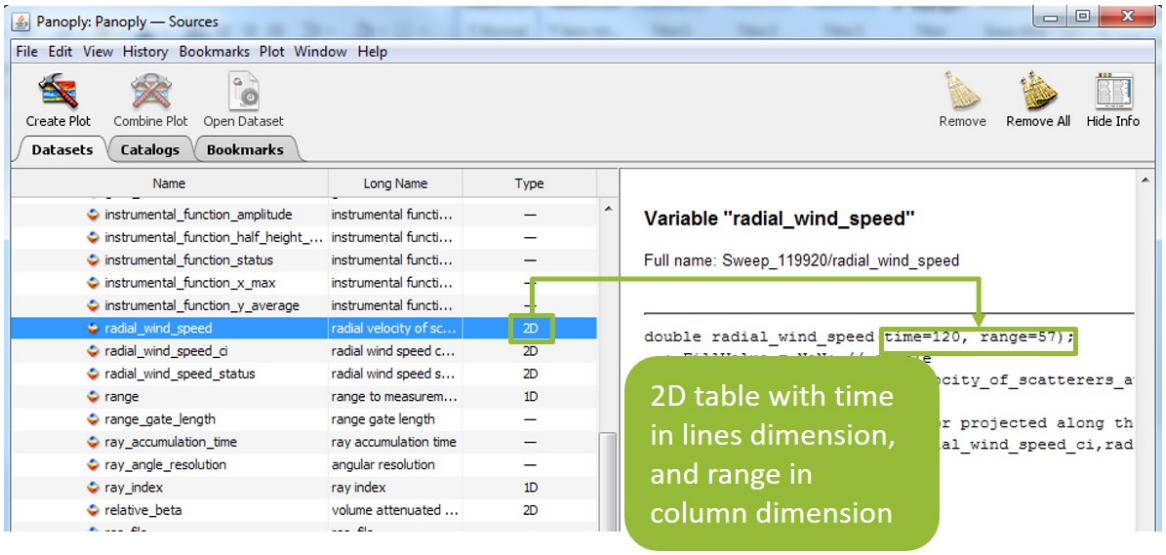


Click on the file name to see the full architecture of the file summarized in the meta-data window. In particular the “global attributes” can be read by scrolling down to the bottom of this meta-data window.

If a field has been selected but there is no available data, this field will still be visible in the **NetCDF** files with values to “NaN” except in vortex mode where there will be no exported files (except the spectra always in **CSV**).



All variables are either scalar values or linked to dimension variables. For instance, in a **PPI** file, **`radial_wind_speed`** is a 2D table with time in lines dimension, and range in column dimension. Time and range are dimensions.



All wind and aerosol variables (`radial_wind_speed`, cnr etc.) are **2 dimensional**:

- The first dimension is always the time (that identifies each ray).
- The second dimension is either range or `gate_index`. The gate index is an identification number of each range.

CAUTION!

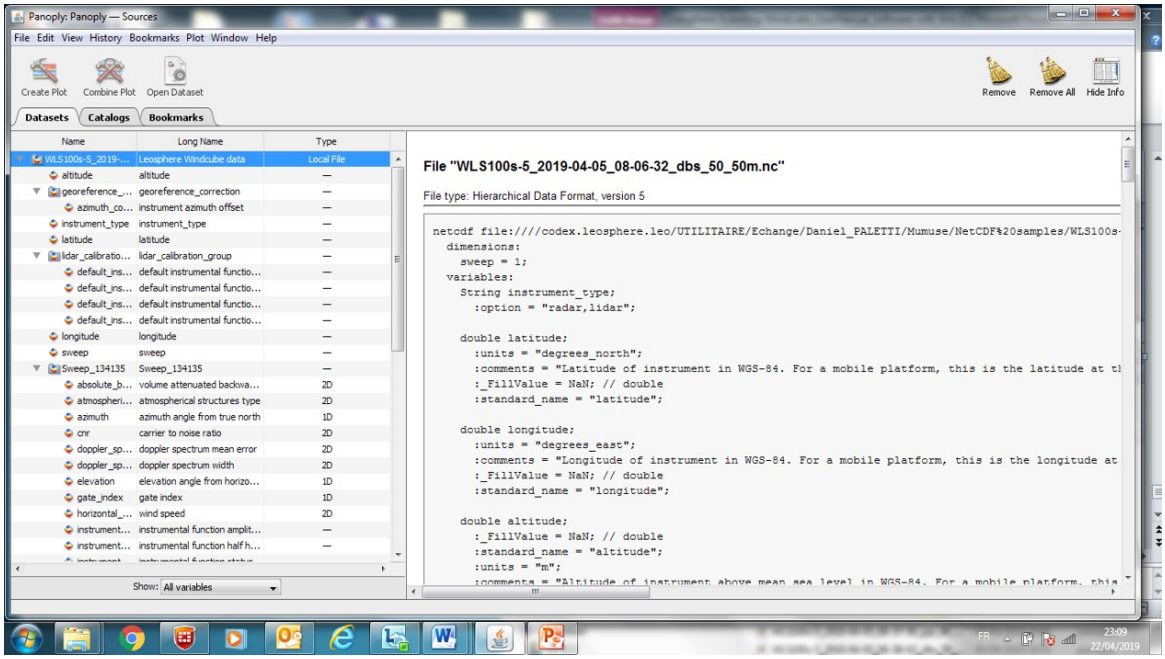
- Range is used whenever it is constant along the time (**PPI**, **RHI**, **FIXED**). In that case, gate_index is a simple 1D variable depending on range.
- `Gate_index` is used whenever range is not constant (**DBS**). In that case, range is a simple 2D variable depending on time and `gate_index`.

The following table indicates which variables are written in the**NetCDF** files, according to the group chosen:

Table 22 Groups and variables in NetCDF files

Group	Variable
`radial_wind_data`	radial_wind_speed doppler_spectrum_width doppler_spectrum_mean_error cnr radial_wind_speed_ci radial_wind_speed_status
`wind_reconstruction_data`	horizontal_wind_speed vertical_wind_speed wind_direction wind_speed_ci wind_speed_status
`radial_beta_data` (optional)	relative_beta radial_wind_speed_status instrumental_function_x_max instrumental_function_y_average instrumental_function_amplitude instrumental_function_half_height_width instrumental_function_status

Group	Variable
`radial_absolute_beta_data` (optional)	absolute_beta radial_wind_speed_status instrumental_function_x_max instrumental_function_y_average instrumental_function_amplitude instrumental_function_half_height_width instrumental_function_status
`atmospherical_structure_data` (optional)	atmospherical_structures_type



The **NetCDF** file generation timeout is 30 minutes. Beyond this time, the file export will be interrupted.

Several powerful freewares are available on internet to read, explore and plot **NetCDF** file. We recommend you to use Panoply software or/and HDFview software:

- https://www.giss.nasa.gov/tools/panoply/download/
- https://www.hdfgroup.org/downloads/hdfview/

More information

- NetCDF file format (page 128)

6.7.3 Global and group attributes description

The following table gives a description and the type of all global or group attributes.

Table 23 Global attributes description and type

Global Attributes	Description	Type
title	“Leosphere Windcube data”	String
Conventions	Gives a coma separated list of convention on which is based the **NetCDF** architecture	String
institution	“Leosphere”	String
references	Empty attribute. Could be used in the future	String
source	“Lidar measurement”	String
history	Specifies the Windcube Lidar server version used to generate the **NetCDF** file. Characterizes the data format architecture revision.	String
comment	Empty attribute. Could be used in the future	String
instrument_name	Lidar’s serial number	String

Table 24 Sweep descripton and type

(Sweep) group attributes	Description	Type
scan_file_name	Name of the scan file integrated in the **NetCDF**	String
scan_id	**ID** of the scan that was used to generate this file (stored as a string)	String
res_file_name	Name of the **Resolution files** integrated in the **NetCDF**	String
res_id	**ID** of the resolution that was used to generate this file (stored as a string)	String
settings_file_name	Name of the settings file integrated in the **NetCDF**	String
settings_id	**ID** of the settings that was used to generate this file (stored as a string)	String

6.7.4 Variables list and definition

The following table summarizes the key parameters of all variables and attributes and reminds the **comments** attribute when available. Of course this information is contained in the **NetCDF** files themselves.

Presence column indicates if the variable/attribute is added in the **NetCDF** files according to the choice made by the user in the **DATABASE** tab or in the **FTP** configuration:

- Always = this variable/attribute is always contained in the file whatever the group(s) chosen
- RWD = Radial wind data group
- WR = Wind reconstruction data group
- RB = Radial beta data group
- AB = Radial absolute beta data group

- ATM = Atmospherical structure data group

Table 25 Parameters for variables/attributes and comment field

Group	Nature	Variable/ attribute Name	Type	Dimensions	Presence	Comments
root	dimension	sweep	int	-	always	Number of sweeps in the dataset.
root	variable	instrument_type	string	-	always	
root	variable	latitude	double	-	always	Latitude of instrument in WGS-84. For a mobile platform, this is the latitude at the start of the volume.
root	variable	longitude	double	-	always	Longitude of instrument in WGS-84. For a mobile platform, this is the longitude at the start of the volume.
root	variable	altitude	double	-	always	Altitude of instrument above mean sea level in WGS-84. For a mobile platform, this is the altitude at the start of the volume.
root	variable	sweep_group_name	string	[sweep]	always	Array of names of each sweep group in file.

Group	Nature	Variable/ attribute Name	Type	Dimensions	Presence	Comments
root	variable	sweep_fixed_ angle	double	[sweep]	always	Array of angles of each sweep in file. Azimuth(s) for RHI, elevation(s) for other modes including[AR1] FIXED line of sight.
sweep i	variable	sweep_mode	string	-	always	
sweep i	variable	sweep_index	int	-	always	Identification number of the current sweep.
sweep i	variable	scan_file	char	-	always	Binary content of scan file.
sweep i	variable	res_file	char	-	always	Binary content of res file.
sweep i	variable	settings_file	char	-	always	Binary content of settings file.
sweep i	variable	rotation_dire ction	string	-	always in PPI/RHI	
sweep i	variable	ray_angle_re solution	double	-	always	Angle between the center of two consecutive rays when scanning head's angular speed, and accumulation time are constants.
sweep i	variable	time_referen ce	string	-	always	UTC reference date. Format follows ISO 8601 standard.

Group	Nature	Variable/ attribute Name	Type	Dimensions	Presence	Comments
sweep i	dimension	time	double	[time]	always	Number of seconds between time_reference and the end of each ray measurement.
sweep i	variable	ray_index	double	[time]	always	Identification number of each ray.
sweep i	variable	timestamp	string	[time]	always	Timestamp at the end of each ray measurement following ISO8601 standard
sweep i	dimension/ variable	projection_range_coordinate	int	[range] or [time] [gate_index]	always	Distance along the line of sight, between the instrument and the center of each range gate. Either a dimension or a variable. When this vector is a dimension, gate_index is a variable and vice versa.
sweep i	variable	measurement_height	double	[range] or [time] [gate_index]	always, in DBS	Vertical distance normal to the ground, between the instrument and the center of each range gate.

Group	Nature	Variable/ attribute Name	Type	Dimensions	Presence	Comments
sweep i	dimension/ variable	gate_index	int	-	always	Identification number of each range gate. Either a dimension or a variable. When this vector is a dimension, range is a variable and vice versa.
sweep i	variable	azimuth	double	[time]	always	Scanning head's azimuth angle relative to true north when each measurement finished. 0 to 360. 0 is the North, 90 is the East. This angle only incorporates azimuth_correction. The Lidar is not supposed to be moving.
sweep i	variable	elevation	double	[time]	always	Scanning head's elevation angle relative to horizontal plane when each measurement finished. -90 to 90. 90 is the zenith. This angle does not incorporate any automatic corrections. The Lidar is not supposed to be moving.
sweep i	variable	range_gate_length	double	-	always	Radial dimension of range gates

Group	Nature	Variable/ attribute Name	Type	Dimensions	Presence	Comments
sweep i	variable	radial_wind_ speed	double	[time] [range/ gate_index]	RWD	Wind speed vector projected along the line of sights.
sweep i	variable	cnr	double	[time] [range/ gate_index]	RWD	
sweep i	variable	doppler_spec trum_width	double	[time] [range/ gate_index]	RWD	Full width at half maximum of the spectrum. Representativ e of particules speed dispersion in the range gate.
sweep i	variable	doppler_spec trum_mean_ error	double	[time] [range/ gate_index]	RWD	Root Mean Square Error between the measured Doppler spectrum and the estimated Doppler spectrum.
sweep i	variable	radial_wind_ speed_ci	double	[time] [range/ gate_index]	RWD	Quality indicator between 0 and 100.
sweep i	variable	radial_wind_ speed_status	ubyte	[time] [range/ gate_index]	RWD	0 for rejected data and 1 for accepted data. A data is rejected if the confidence index is below a threshold calibrated in factory or when radial wind speed is out of the accepted range.

Group	Nature	Variable/ attribute Name	Type	Dimensions	Presence	Comments
sweep i	variable	horizontal_wind_speed	double	[time] [gate_index]	WR	Norm of the wind projection on local horizontal plane.
sweep i	variable	vertical_wind_speed	double	[time] [gate_index]	WR	Vertical component of the wind. Positive towards zenith.
sweep i	variable	wind_direction	double	[time] [gate_index]	WR	Wind direction with respect to true north, (0=wind coming from the north, 90=east, 180=south, 270=west)
sweep i	variable	wind_speed_ci	double	[time] [gate_index]	WR	For inclined lines of sight this figure is equal to 0, 75 or 100 depending on the number of line of sight used for the reconstruction (maximum 4 lines of sight are used). For vertical lines of sight this figure is equal to 100 when the status of the radial wind speed is equal to 1.

Group	Nature	Variable/ attribute Name	Type	Dimensions	Presence	Comments
sweep i	variable	wind_speed_ status	ubyte	[time] [gate_index]	WR	0 for rejected data and 1 for accepted data. A data is rejected if its confidence index is lower than 100.
sweep i	variable	relative_beta	double	[time] [range/ gate_index]	RB	Attenuated relative backscatter coefficient. Processed from the CNR.
sweep i	variable	absolute_bet a	double	[time] [range/ gate_index]	AB	Attenuated absolute backscatter coefficient. Processed from the CNR.
sweep i	variable	atmospherica l_structures_ type	int	[time] [range/ gate_index]	ATM	Atmospheric al structures detected out of the planetary boundary layer.
sweep i	variable	ray_accumul ation_time	int	-	always	Time during which the detector collects light. A ray is defined by this duration.
sweep i	variable	instrumental_ function_x_ max	double	-	RB, AB	Maximum horizontal axis of the Lorentz distribution obtained in the last calibration.

Group	Nature	Variable/ attribute Name	Type	Dimensions	Presence	Comments
sweep i	variable	instrumental_function_y_average	double	-	RB,AB	Average value of the y-axis of the Lorentz distribution obtained in the last calibration.
sweep i	variable	instrumental_function_amplitude	double	-	RB, AB	Amplitude of variations of the Lorentz distribution obtained in the last calibration.
sweep i	variable	instrumental_function_half_height_width	double	-	RB, AB	Scale parameter specifying the half height width of the Lorentz distribution obtained in the last calibration.
sweep i	variable	instrumental_function_status	ubyte	-	RB, AB	0 for rejected data and 1 for accepted data. Data is rejected if the beta calibration is not successful.
lidar_calibration group	variable	default_instrumental_function_x_max	double	-	RB, AB	Default maximum horizontal axis of the Lorentz distribution used for beta computation.
lidar_calibration group	variable	default_instrumental_function_y_average	double	-	RB, AB	Default average value of the y-axis of the Lorentz distribution used for beta computation.

Group	Nature	Variable/ attribute Name	Type	Dimensions	Presence	Comments
lidar_calibration group	variable	default_instrumental_function_amplitude	double	-	RB, AB	Default amplitude of variations of the Lorentz distribution used for beta computation.
lidar_calibration group	variable	default_instrumental_function_half_height_width	double	-	RB, AB	Default scale parameter specifying the half height width of the Lorentz distribution used for beta computation.
georeference_correction	variable	azimuth_correction	double	-	always	Azimuth offset angle used if the Lidar cannot be physically oriented to the North.

6.7.5 Variable's attributes description

The following table gives a description and the type of all attributes that can be used to characterize variables.

All variables are not necessarily qualified by all attributes.

Table 26 Variable's attributes description

Attribute	Description	Type
`_FillValue`	Indicates what default value is used if no data is available.	Same as variable to which it is attached
`ancilliary_variables`	Indicates what variables are used to characterize the current one. For instance `radial_wind_speed` variable has `radial_wind_speed_ci` and `radial_wind_speed_status` as ancillary variables.	String (coma separated)
`axis`	Defines the axis of coordinate variables	String
`Calendar`	Defines the calendar used for variable time.	String
`comments`	Defines the variable.	String

Attribute	Description	Type
flag_masks	Describes a number of independent Boolean conditions using unique bits in each flag_masks value. This attribute is systematically associated with the flag_meanings attribute. Example : in the atmospherical_structures_type, a 2 in the tens digit signifies “residual layer” and a 3 in the tens digit signifies “mixed layer”	Same as variable to which it is attached
flag_meanings	String whose value is a coma separated list of descriptive words or phrases, one for each flag_values or flag_masks.	String (coma separated)
flag_values	Contains a list of the possible flag values. This attribute is systematically associated with the flag_meanings attribute.	Same as variable to which it is attached
is_quality_field	Indicates if this variable qualifies another.	String: “true” or “false”
long_name	Used : • instead of standard_name when no standard_name has been defined for a given quantity. • or additionally to the standard_name to give additional information on the variable content	String
meters_between_gates	Indicates the distance between the centers of 2 consecutive range gates when spacing_is_constant is true.	String
meters_to_center_of_first_gate	Indicates the distance to the center of the first range gate.	String
option	Gives all possible options when a variable can take only pre-determined values. For instance, options are “direct” or “indirect” for the variable rotation_direction.	String (coma separated)
qualified_variables	Indicates what variables are characterized by the current (ancillary) one. For instance radial_wind_speed_status qualifies radial_wind_speed.	String (coma separated)
spacing_is_constant	Indicates if spacing between range gates is constant	String: “true” or “false”
standard_name	Describes the physical quantity of a variable. The Cf convention standardized a list of standard_name http://cfconventions.org/Data/cf-standard-names/65/build/cf-standard-name-table.html. We used the values given by the Cf convention when available. Otherwise, this field has been left empty and long_name attribute was used instead.	String
units	Unit of the variable to which it is attached. This attribute is not implemented if a variable has no unit. Possible values are: degrees_north, degrees_east, m, degrees, seconds since time_reference, m s-1, dB, percent, m-1 sr-1, ms	String

6.7.6 Atmospherical structures variable description

Some of the variables in the **NetCDF** format are flag variables. In addition to the raw flag data, these variables contain attributes that describe how the flag values are interpreted. This is the case for atmospherical structures; the structures are defined according to the flags below:

Table 27 Structure types accoding to flags

Flag	Structure type
0000	No data or no detection
0020	Residual layer
0030	Mixed layer
0200	Unclassified cloud
0300	Ice cloud
0400	Water cloud
2000	Unclassified aerosol
3000	Spherical aerosol
4000	Aspherical aerosol

6.8 Other files formats description

In this chapter we will see all other files formats descrition:

- Spectral data file
- Activity file
- Status file
- Environmental data file
- Scan, settings and resolutions files

6.8.1 Spectral Data file (Optional)

Spectra are exported as **CSV**. The following table specifies their content.

Table 28 Spectral Data file description

Header	Description
Timestamp	Time and date (UTC) when the measurement finished. YYYY-MM-DD hh:mm:ss.sss
Settings ID	Identifier of the configuration used to perform the measurement
Resolution ID	Identifier of the **resolution** used to perform the measurement
Scan ID	Identifier of the scan used to perform the measurement.

Header	Description
LOS ID	Identifier of the line of sight (**LOS**) along which the raw signal data is measured. It is defined by an accumulation.
Sequence ID	Identifier of the sequence when the measurement was performed
Azimuth [°]	Current **LOS azimuth angle**
Elevation [°]	Current **LOS elevation angle**
Range [m]	Distance along the current **LOS**
Spectral density [A.U]	Power Spectral Density measured (arbitrary unit). 64, 128, 256 or 512 points according to system and the range gate length chosen.

Spectra files are only available if the **Spectrum Recording** has been activated (optional).

6.8.2 Activity file

Table 29 Activity file description

Header	Description
Timestamp	UTC date when an action occurred. YYYY-MM-DD hh:mm:ss.sss
Action	Action log.
User	User's name responsible of each action done on the system.

The following table describes all log messages:

Table 30 Log messages

Action/log	Meaning
`BOOT_LIDAR_PC`	Lidar PC has been turned on
`LOG_IN`	A user connected to the Lidar through GUI
`NEW_RESOLUTION ID`	A new resolution has been added to resolutions library
`NEW_SETTINGS ID`	A new setting has been added to settings library
`REBOOT_LIDAR_PC_GUI`	A user pushed [SHUT DOWN] button to reboot Lidar PC
`REBOOT_LIDAR_PC_MONIT_ADMIN`	Lidar PC has been rebooted via **Monit** (Leosphere technical support action)
`REBOOT_LIDAR_PC_MONIT_CUSTOMER`	Lidar PC has been rebooted via **Monit** (customer action)
`RESTART_SERVER_PROCESS_GUI`	A user pushed [SHUT DOWN] button to reboot the software

Action/log	Meaning
RESTART_SERVER_PROCESS_MONIT_ADMIN	Lidar server process has been restarted via **Monit** (Leosphere technical support action)
RESTART_SERVER_PROCESS_MONIT_CUSTOMER	Lidar server process has been restarted via **Monit** (customer action)
SHUTDOWN_LIDAR_PC	A user pushed the shutdown button (physical button inside the Lidar) to switch off Lidar PC
SHUTDOWN_LIDAR_PC_GUI	A user pushed [SHUT DOWN] button to switch off Lidar PC
SHUTDOWN_LIDAR_PC_UPS	The UPS launched a PC shut down command to switch off Lidar PC
START_ACQUIRING	A user pushed [START] button or Lidar started measurement automatically
START_OPERATING	A user pushed [SYSTEM CONTROL] button
START_SERVER_PROCESS_MONIT_ADMIN	Lidar server process has been started via **Monit** (Leosphere technical support action)
START_SERVER_PROCESS_MONIT_CUSTOMER	Lidar server process has been started via **Monit** (customer action)
START_SERVICE	Lidar server process has been started/ restarted by SSH (Leosphere technical support action)
STOP_AQCUIRING	A user pushed [STOP] button or Lidar stopped measurement automatically
STOP_OPERATING	A user released [SYSTEM CONTROL] button
STOP_SERVER_PROCESS_GUI	A user pushed [SHUT DOWN] button to stop the software
STOP_SERVER_PROCESS_MONIT_ADMIN	Lidar server process has been stopped via **Monit** (Leosphere technical support action)
STOP_SERVER_PROCESS_MONIT_CUSTOMER	Lidar server process has been stopped via **Monit** (customer action)
STOP_SERVICE	Lidar server process has been stopped/restarted by SSH (Leosphere technical support action).
SUBMIT	Lidar programming has been changed. Happens in general when pushing [START] button.
REBOOT_LIDAR_PC_API	Lidar PC has been reboot by the **API**
RESTART_SERVER_PROCESS_API	Lidar server has been restarted by the **API**
SHUTDOWN_PC_API	Lidar PC has been shut down by the **API**
STOP_SERVER_PROCESS_API	Lidar server has been stopped by the **API**
START_EXTRACTION	The extraction via the GUI is triggered
STOP_EXTRACTION	The extraction via the GUI is stopped

6.8.3 Status file

Table 31 Status file description

Header	Description
Timestamp	Time and date (UTC) when the status changed: YYYY-MM-DD hh:mm:ss.sss
Device	Device (or measurement) name
Status	Device status
Explanation	Short explanation of status state
Code	Status code. Can be given to Leosphere technical support for advanced diagnosis

6.8.4 Environmental Data file

Environmental data is written on the hour and half an hour (10:00, 10:30, 11:00 etc...).

Table 32 Environmental Data file description

Timestamp	Name	Unit	Sample Number	Meaning
Start time and date (UTC) of observed period Format is YYYY-MM-DD hh:mm:ss.ss	gps_last_ntp_synchronization	-	Number of samples used on observed period (= 1)	Date of last GPS synchronization if occurred during the observed period Format is YYYY-MM-DD hh:mm:ss.ss
	ntp_last_ntp_synchronization	-		Date of last NTP synchronization if occurred during the observed period Format is YYYY-MM-DD hh:mm:ss.ss
	disk_occupation	%		Hard drive free space available at the end of observed period Format is xx
	gps_lat	°		Last latitude detected at the end of observed period Format is x.xxxxx
	gps_long	°		Last longitude detected at the end of observed period Format is x.xxxxx
	Pitch	°	Number of average values (when existing values) OR Number of missing values (when no data)	Average, min or max pitch angle over the period
	Roll	°		Average, min or max roll angle over the period
	internal_temperature	°C		Average, min or max internal temperature over the period
	internal_RH	%		Average, min or max internal relative humidity over the period
	external_temperature	°C		Average, min or max external temperature over the period (if PTU probe plugged)
	external_pressure	hPa		Average, min or max external pressure over the period (if PTU probe plugged)
	external_RH	%		Average, min or max external relative humidity over the period (if PTU probe plugged)
	dew_point	°C		Average, min or max internal dew point over the period

6.8.5 Scan, settings and resolutions files

There are two XML settings file gathering all the parameters defining a given setting:

- `.set` : encrypted format that can only be imported on the Lidar. It contains all system settings.
- `.xset` : can be read with a text editor. The content depends on the user profile. This file contains all parameters visible by your profile.

There are two XML scan files gathering all the parameters defining a given scan:

- `.scan`: encrypted format that can only be imported on the Lidar.
- `.xscan`: can be read with a text editor, contains the scan configuration.

The **resolution** is an “advanced setting” containing all parameters linked to the **RANGE GATE LENGTH** and the laser pulse. The Lidar contains at least 4 resolutions: one for each **RANGE GATE LENGTH**. The export of the resolutions (.res) is exclusively reserved for internal use in Leosphere. Content of resolution files is encrypted.

Scan, settings and **Resolution files** are named are as follows:

`SystemID_ID_Name.(x)scan/(x)set/res`

Table 33 Scan, settings and resolutions files description

Parameter	Description	Format
`SystemID`	System serial number	WLS-x00S-xxx
`ID`	Scan ID / Settings ID / Resolution ID	Integer
`Name`	Scan name / Settings name / Resolution name	Text

CAUTION! For scan settings and resolutions files names, note that these 3 file names are limited to 64 characters. For **Name** and **Description** fields, the only characters allowed are letters, uppercase or lowercase, numbers and - _ + = and space.

Appendix A. Identification memo

A.1 Identification Memo

Login and **Password** are defined by default in the factory. The user with sufficient rights can modify them. Once modified, LEOSPHERE won't be able to retrieve login and password remotely.

IDs SET INITIALLY BY DEFAULT:

Login.....

Password:.....

IP Address: .....

IDs modified by the user or during installation:

Table 34 Identification Memo

DATE	LIDAR IP ADDRESS	LOGIN	PASSWORD
...../...../.....			
...../...../.....			
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...../...../.....			
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Appendix B. Leosphere API

B.1 Leosphere API

Based on simple REST principles, the Leosphere Web **API** server returns JSON data or files. REST (Representational State Transfer) is an architectural style that defines a set of constraints to be used for creating web services based on HTTP protocol.

The default base address of Leosphere Web **API** is *http://*<host>, where <host> is your Lidar**IP Address**. All requests to Leosphere Web **API** require an authentication. This is achieved by sending a valid access token in the request header.

These features are available only for expert profile.

B.2 API connection

There are many software available on Internet to test a Web API “manually” (without coding a dedicated software). For instance, Postman from https://www.getpostman.com/downloads/. This software is indicated as an example, if you want to make some tests. For an operational use, you must create your own application.

B.3 Syntax generic principles

In your Workspace, the 3 principal parts are the URL, **Headers**, and the **Body**.

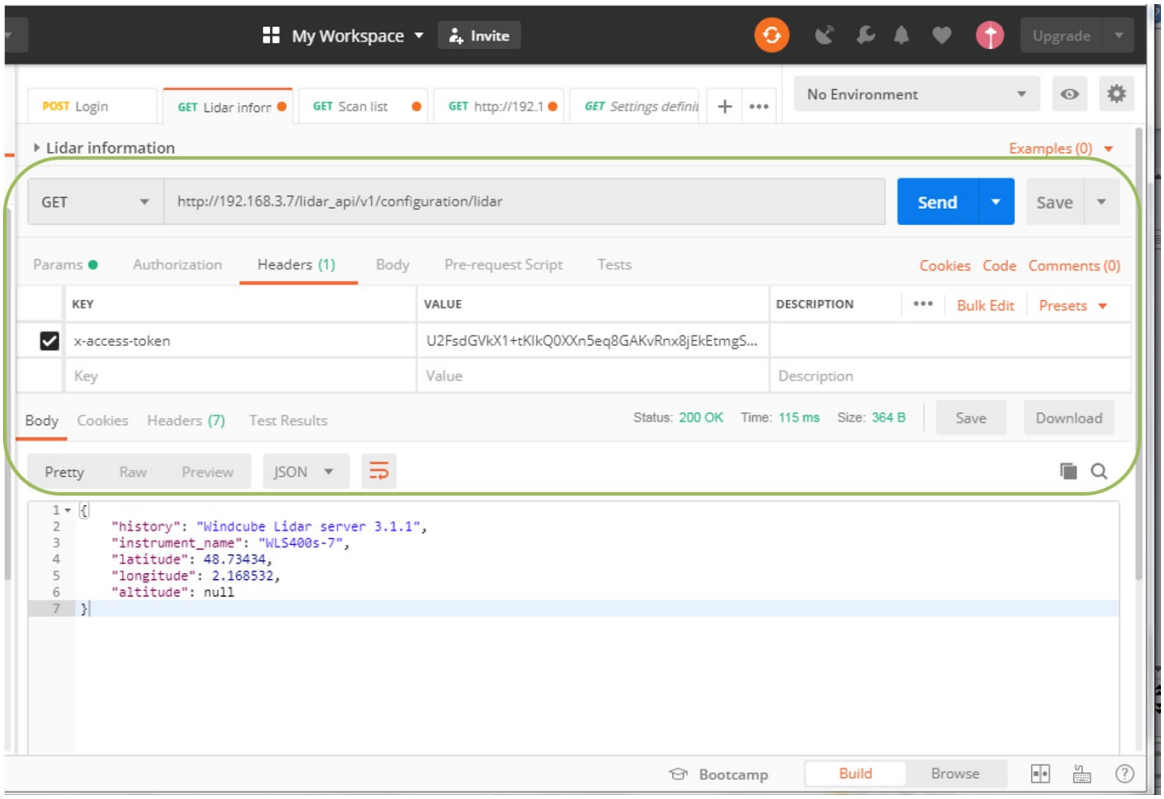


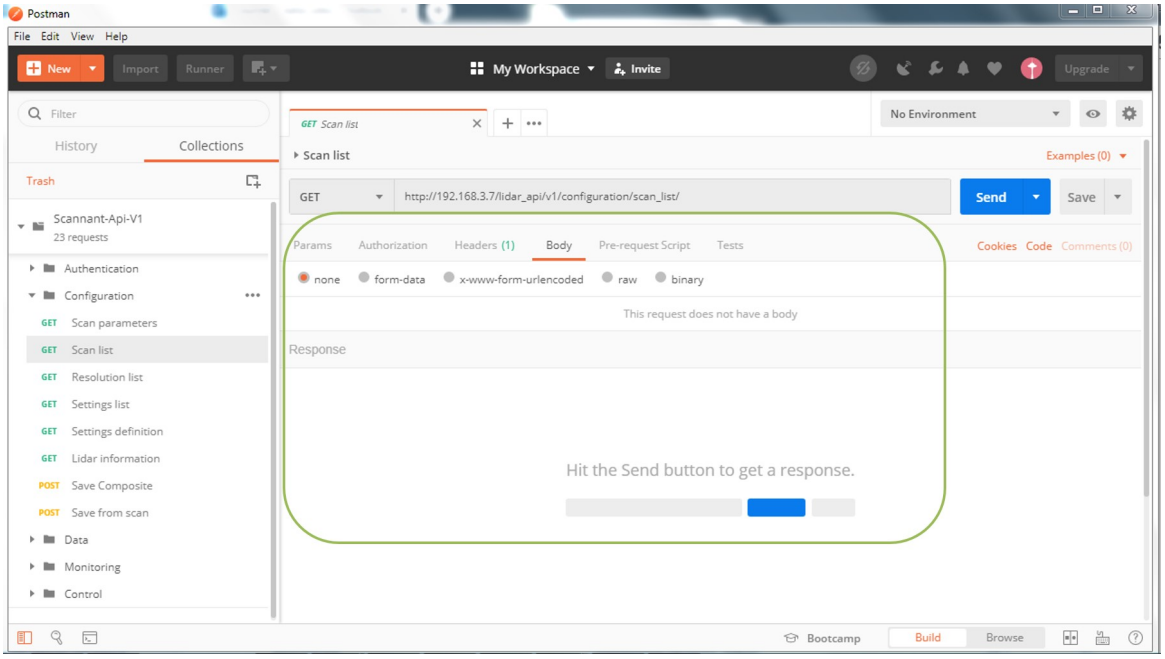
Figure 35 API connection

Headers

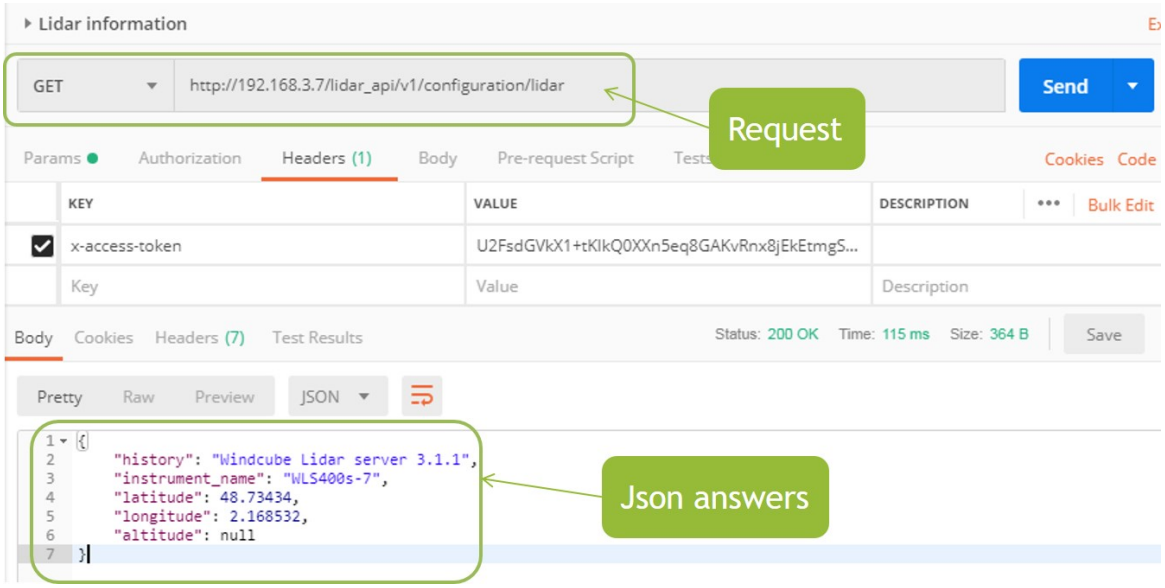
Clicking on the **Headers** tab shows the headers key-value editor (see screenshot above). You can set any string as the header name. The autocomplete dropdown provides suggestions of common HTTP headers, as you type in the fields. Values for the `Content-Type` header are also available in an auto-complete drop down.

Request body

While constructing requests, you'll work frequently with the request body editor. Postman lets you send almost any kind of HTTP request. The body editor is divided into 4 areas and has different controls, depending on the body type. In the body editor, it is allowed to use JSON requests by selecting the raw option.



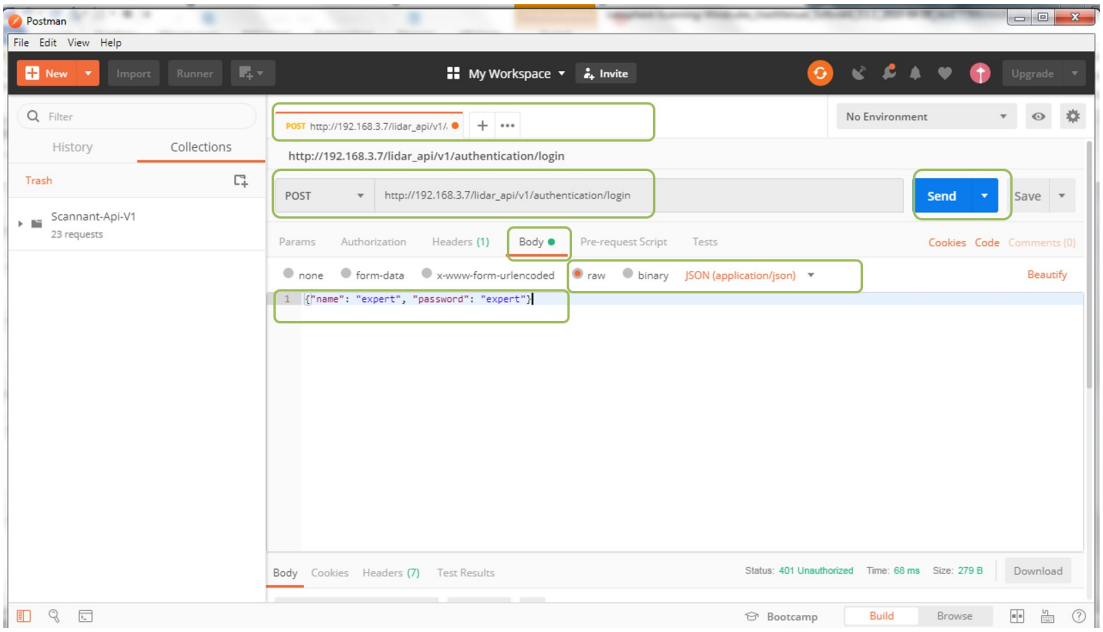
Most of the requests respond with JSON data. An object is a dataset of both properties and values, it is represented by { `“property1”: “value1”, “property2”: “value2”`}.



B.4 Authentication and getting token in Postman software

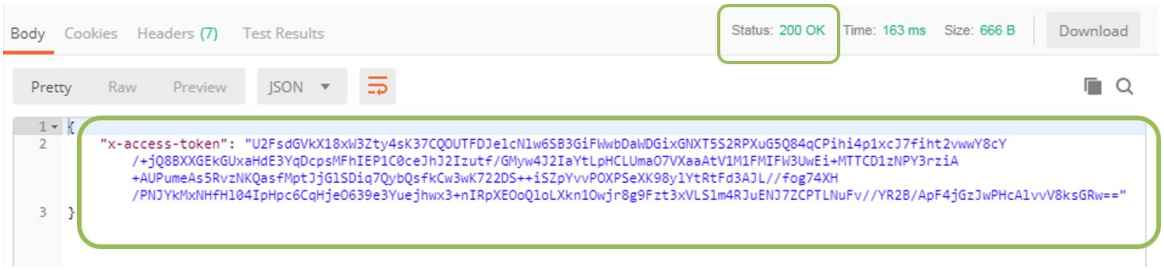
An **API** token is a unique identifier of an application requesting access to your service. An **API** token is the form of authentication similar to a username/password.

1. Open Postman software.
2. Go to the top part, click on the **+** to make a request.



3. Select **POST** in the drop down menu.
4. Enter *http://<host>/lidar_api/v1/authentication/login.*
5. Select **Body** sub-tab.
6. Select **raw** radio button and **JSON (application/json)** in the drop down menu, on the right.
7. Enter the **Name** and **Password** (`expert` by default).
8. Click on **Send** button.

You receive immediately your token, in the lower part of your screen, the status is then **OK**.



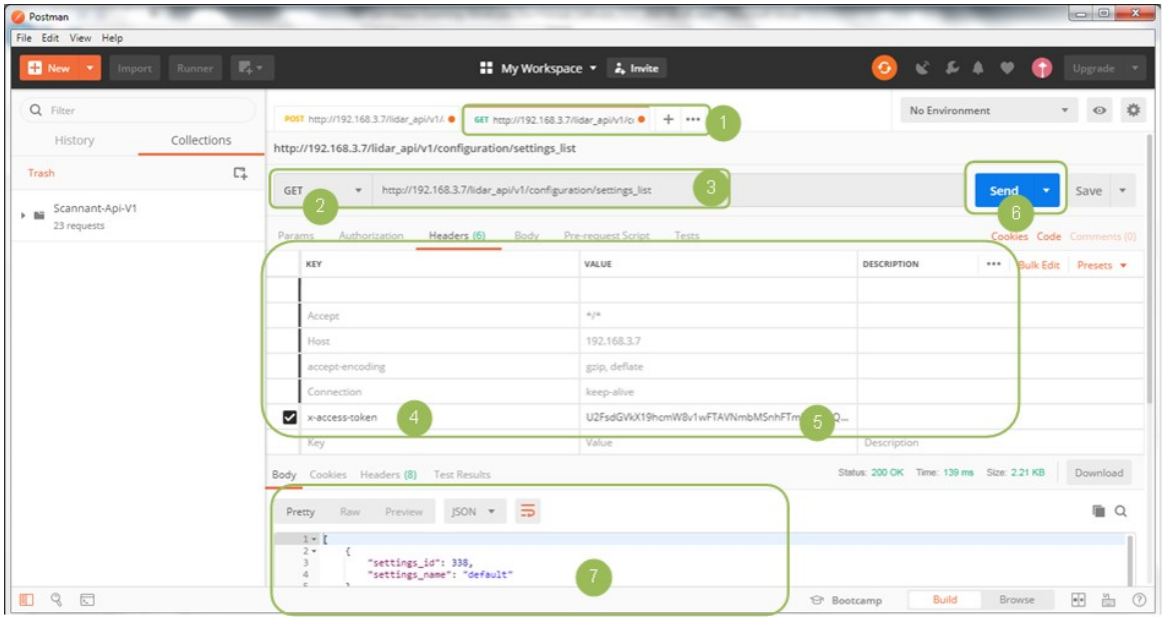
CAUTION! Copy your token (the whole part in quotes).
Be careful, your token is configurable between 1h and 24h.
In case of a system reboot, the token will no longer be valid. You will have to request a new one (by making the same steps as described above).

B.5 Asking a request

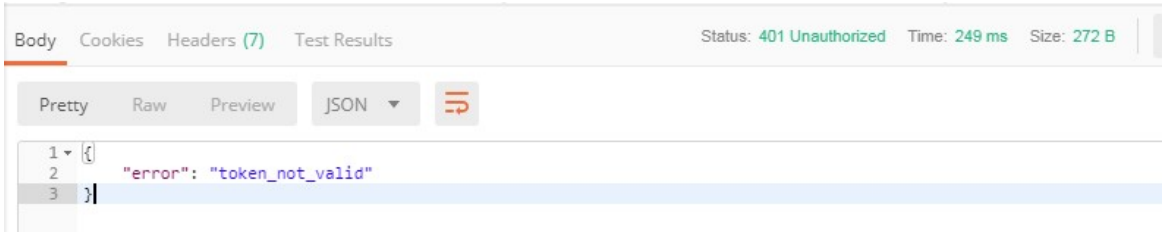
The request in the example below is **`Get list of scans in library`**.

1. Go to the top part, click on the **+** to make a request.
2. Select **GET** in the dropdown menu.
3. Enter *`http://<host>/lidar_api/v1/configuration/scan_list.`*
4. Enter the key in **KEY** field (`x-access-token`).
5. Enter your token in **VALUE** field.
6. Click on **Send** button.

The Lidar's answer is displayed in the lower part of the screen.



In case of an error, a message warns you and status is not **OK**.



Glossary

Accumulation time
Time for the acquisition of one LOS (Line Of Sight).

Angular resolution
Angular sector covering one LOS.

API
application programming interface

AU
Arbitrary Unit

Azimuth angle
Angle between the projection of the line of sight on the local horizontal plane and the geometric North. This angle is comprised between 0° and 360° (0° is the North and 90° is the East).

CNR
Carrier to **N**oise **R**atio. This value depends on the aerosol concentration in the atmosphere. High atmospheric backscatter coefficient leads to high **CNR**. **CNR** level depends on weather conditions.

Composite
Scan made of several scans.

DBS
« **D**oppler **B**eam **S**winging technique ». Scan that points the beam at 5 different lines of sight (**LOS**) including 4 **LOS** spaced 90° apart with a fixed **elevation angle**, and one vertical **LOS**.

Elevation angle
Angle between the line of sight and the local horizontal plane. This angle is comprised between -90° and 90° (-90° is the Nadir, 90° is the Zenith).

Fixed
Fixed **L**ine **O**f **S**ight scan

NetCDF
Network Common Data Form. NetCDF is a set of software libraries and self-describing, machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data.

PPI
« **P**lan **P**osition **I**ndicator ». Constant **elevation angle** scan

PSD
Power **S**pectral **D**ensity

Range
Distance between Lidar and measurement point (range gate center)

Range gate length

Radial length taken into account to measure the wind. This length is linked to the Laser pulse duration. The **RANGE GATE LENGTH** is also a parameter of the scan (in Scan Editor tab). A scan is directly related to a **RANGE GATE LENGTH** and it is not possible to associate the same scan with different Range Gate Lengths.

Ray

In NetCDF files, **ray** stands for **Line of Sight**

Resolution

A Resolution is an “advanced setting” containing all parameters linked to the Range Gate Length and the laser pulse. The Lidar contains at least 4 resolutions: one for each Range Gate Length.

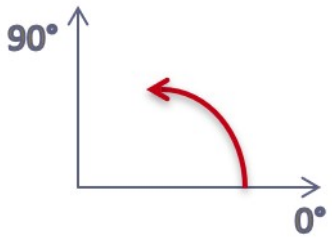
RHI

« **R**ange **H**eight **I**ndicator ». Constant azimuth angle scan

Rotation direction

Rotation direction of the scanner head:

- For **PPI**, “direct” in rotationdirection fieldis clockwise (scan seen from above)
- For **RHI**, “direct” in rotationdirection fieldis on the direction defined below (scan seen from above):



Rotation speed

Scanning head angular speed (°/s)

Sequence

A sequence = one scan iteration in **PROGRAMMING** tab.

Sweep

For **NetCDF** format, the used convention proposes to classify the files by sequences. The convention uses the term of **sweep**. In this case, a **sweep** corresponds to a sequence and we have 1 **sweep** per scan (for example: 1 **sweep**= 1 **PPI**

sweep is also collection of **rays** (refer to **ray** in glossary).

Timestamp

Time and date when measurement occurred.

Variable

A **NetCDF** file, is made of one or several **variables**. Each variable is made of:

- A data, which is a multidimensional table or a value
- Several metadata that characterize the data. In metadata, **attributes** are important.

Warranty and Product Returns

Unless provided otherwise, this product and its associated instruments and software are warranted for one (1) year starting from the date of delivery and are applicable only for delivered materials.

The warranty contract provides assistance in case of hardware or software breakdown. It does not include scheduled maintenance operations.

CAUTION! No goods shall be returned without Leosphere prior written agreement. If the user invokes the warranty, Leosphere shall determine intervention methods.

- Return of goods is applicable only to goods that have not been modified or altered in any manner and must be in original packaging.
- The warranty does not cover non-capital goods the cost which are covered by the owner.
- The warranty does not cover replacement and/or repairs resulting from: exterior wear, aging or tear of the instrument components; instrument deterioration, damage or accidents resulting from negligence or disregard for the operating instructions enclosed in this document; lack of supervision, maintenance or stocking, or from manipulation or use not conforming to Leosphere or manufacturer's specifications.
- The warranty does not confer the right to download new system software versions but the right to the replacement of identical system software as acquired by owner at a time of purchase.
- The warranty does not constitute a maintenance contract. A maintenance contract is available separately.

Technical Support

The WINDCUBE®100S-200S-400S users have access to a free Hotline in the case when any assistance is required, regarding the system's operations or maintenance.

Qualified software, optoelectronics and LIDAR engineers provide support

- over the Hotline Phone Number +33 9 72 68 11 11
- support@leosphere.com
- from Monday to Friday between 9:00 am to 5:00 pm (GMT+1)

Recycling

Recycle all applicable material.

Follow the statutory regulations for disposing of the product and packaging.

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