



MAMBO V2 System

User manual

**BOSSA NOVA
VISION**

5777 W. Century Blvd.
Suite 205 - LOS ANGELES
CA 90045 USA

Tel: (424) 394-0321

Fax: (310) 943-3280

www.bossanovavision.com

This Manual describes MAMBO hardware and software. Use this manual as a reference when working with your MAMBO System.

Copyright and Manual Notice

Bossa Nova reserves the right to make changes to this manual and to the items described therein without notice. Bossa Nova has taken considerable effort to ensure that the information in this manual is accurate and complete. However, Bossa Nova will not be liable for any technical or editorial errors or omissions made herein or for incidental, special or consequential damages of any nature resulting from the furnishing of this manual, or operation and performance of equipment in connection with this manual.

Table of Contents

1. MAMBO Hardware	5
1.1. List of components	5
1.2. MAMBO system description	6
1.3. Swatch support (optional)	7
2. MAMBO Software	9
2.1. Start-up & Hardware test	9
2.1.1. Camera test	10
2.1.2. Illumination test	11
2.2. Main Window	12
2.2.1. Top Menu	13
2.2.2. Live image & Live data	14
2.3. Standard section	14
2.3.1. Data Management	15
2.3.2. Data Preview	18
2.3.3. Acquiring standard measurement	18
2.3.4. Standard measurements analysis	19
2.4. Color Retention window	22
2.4.1. Color Retention study	22
2.4.2. Create / Delete / Select a study	24
2.4.3. Create / Delete / Organize events	27
2.4.4. Color retention measurements acquisition	29
2.4.5. Color retention measurements preview	30
2.4.6. Color Retention analysis	31
2.5. Database creation and management window	35
2.5.1. Create / Delete / Rename databases	35
2.5.2. Add elements to database	37
2.5.3. Database elements preview	40
2.5.4. Processing the database	40
2.6. Calibration Window (Advanced user)	41
2.6.1. X / Y adjustment	44
2.6.2. Exposure	44
2.6.3. White Balance	45
2.6.4. Flat Field image	45
2.6.5. Offset image	46
2.7. Color Calibration Window (Advanced user)	46
2.7.1. Add a new Color Calibration	48
2.7.2. Add / Replace elements to the Color Calibration	49
2.7.3. Generate the Calibration files	50
2.7.4. Select the Color Calibration to use with MAMBO	51
2.7.5. Delete / Rename Color Calibrations	51
2.8. Illumination check calibration (Advanced User)	52
2.9. Standard export	54
2.9.1. Filling in your export list	55
2.9.2. Adding comparison values	56

2.9.3.	<i>Exporting the data</i>	58
2.9.4.	<i>Exiting the standard export</i>	58
2.10.	Color Retention Export	59
3.	Technical Background	60
4.	Technical Specifications	61

1. MAMBO Hardware

1.1. List of components

When unpacking the system, please make sure you have all the following items:

		
MAMBO system	MAMBO Support	USB 3.0 cable
		
Power supply for MAMBO	1 Computer + cables (Laptop or All-in-one)	DataColor - Color Checker
		
Switch support part 1 (optional)	Switch support part 2 (optional)	

Table 1 - List of MAMBO components

1.2. MAMBO system description

Below is a description of the exterior of the MAMBO system:

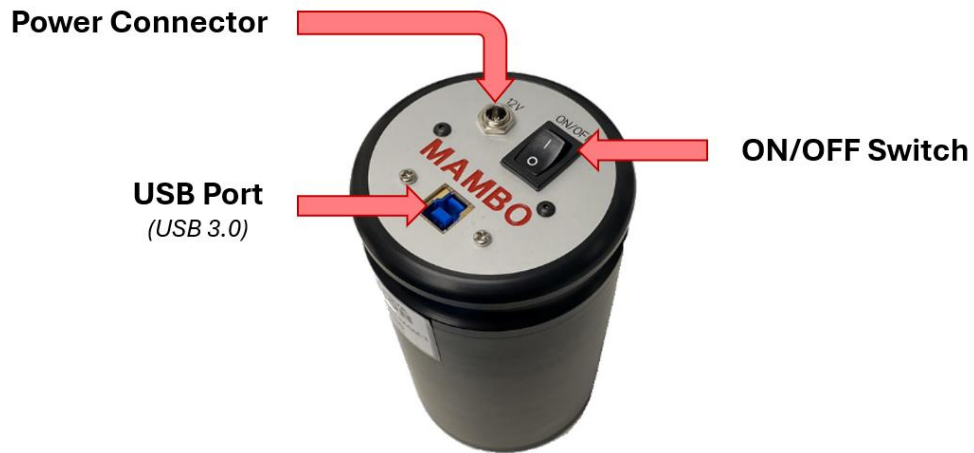


Figure 1 - MAMBO system description

To connect the system:

- Use the USB 3.0 cable (blue interior) to connect the USB Port on the MAMBO to a USB 3.0 port on your computer
- Use the power cable to connect the Power connector to an electric plug



Figure 2 - MAMBO with cables connected

To turn the system on, simply use the on/off switch. When switched on, the light should be turned on in the system (**Figure 3 - MAMBO turned on with swatch support**).



Figure 3 - MAMBO turned on with swatch support

1.3. Swatch support (optional)

The swatch support is an accessory that can be used to standardize your measurements with the MAMBO. It consists of two parts:

- The first part can hold a hair swatch from the metallic end



Figure 4 - Accessory part 1

- The second part can hold the first part of the accessory so that it can slide from under the MAMBO once the MAMBO is placed over the round part (Figure 6)

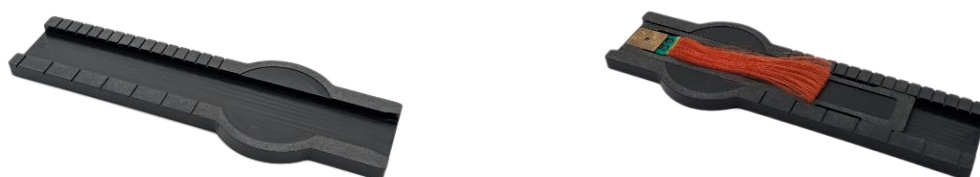


Figure 5 - Accessory part 2



Figure 6 – MAMBO put on the swatch support accessory

Once the accessory is properly set up, you can slide the swatch holder along its support to acquire measurements at different positions.

N.B: This accessory is not necessary to use with the MAMBO, as the system can be put directly on hair swatches or on a subject's head.

2. MAMBO Software

Locate the MAMBO Software icon on the desktop of your computer:



Figure 7 - MAMBO software icon

Double-click to launch the MAMBO software.

- The system doesn't have to be turned on or connected for export and/or measurement preview/analysis
- The system has to be turned on for the acquisition of new measurements, check-up or calibration of the system

2.1. Start-up & Hardware test

When you start the MAMBO software, you will have to choose between the **Live measurement & Load data** mode and the **Load data only** mode:

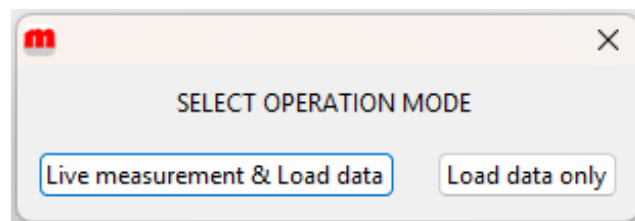


Figure 8 - Operation mode selection window

- Choosing **Load data only** will lead to the main window. The software does not need the hardware to be turned on or connected. The user will only be able to load, process and visualize existing data
- Choosing **Live measurement & load data** leads to an automated test procedure that ensures all hardware components (Camera and LED illumination) are working properly to the factory specifications. After the test, it will open to the main window.

2.1.1. Camera test

The first part of the test is the camera connection and initialization. The process is automated and if the connection is correctly established, a new window will pop-up to proceed with the illumination test (**Figure 9**).

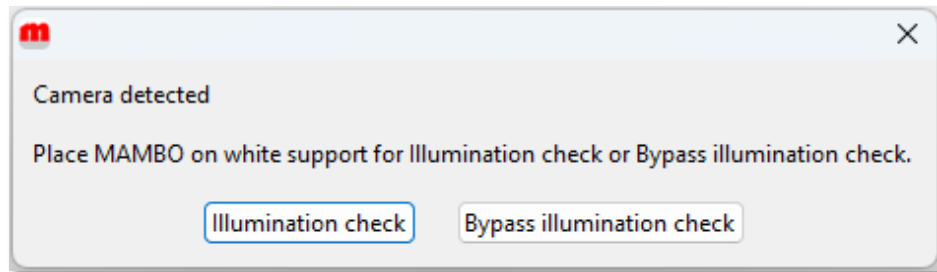


Figure 9 – Camera detected message

You can proceed with the illumination check (**illumination test**) or also bypass the test and start directly with the Live measurement mode.

If there is an issue with the camera itself, the camera connection or the camera initialization, an error message will pop up (**Figure 10**).

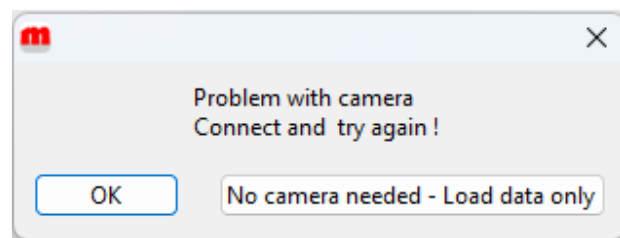


Figure 10 - Camera error message

The window provides 2 options:

- To try the camera connection again. Click on this option after checking that all cables are properly connected to the MAMBO and the computer. If the camera error keeps appearing, contact a BOSSA NOVA Vision employee to troubleshoot the issue
- To proceed with the **Load data only** mode which does not need the hardware and therefore abort the test procedure

2.1.2. Illumination test

The second part of the test is the illumination check. For this process:

- The MAMBO needs to be turned on (**Figure 11**)
- The MAMBO needs to be put on its support (**Figure 11**)



Figure 11 - MAMBO and its illumination check support

Once this has been checked, you can go forward with the illumination check. The software will measure the illumination intensity on all three color channels (red, green and blue) and compare their intensities values to reference values, with a tolerance of +/- 10 %.

If the test is successful (**Figure 12**), you can proceed with the **Live measurement & load data** mode.

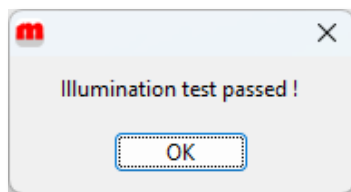


Figure 12 - Illumination test passed window

If the test fails, there are 3 options (**Figure 13**):

- To re-test the illumination again. Click on this option after checking that:
 - all cables are properly connected to the MAMBO and the computer
 - the MAMBO light is properly turned on
 - the MAMBO is properly positioned on the support
 - that the white area on the support is clean

If the camera error keeps appearing, contact a BOSSA NOVA Vision employee to troubleshoot the issue

- To bypass the illumination test and proceed with the **Live measurement & load data** mode
- To proceed with the **Load data only** mode which does not need the hardware and therefore abort the test procedure

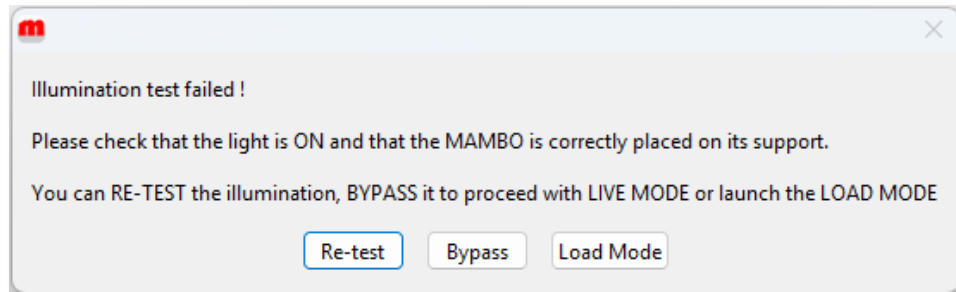


Figure 13 - Illumination test failed window

2.2. Main Window

The main window is presented on *Figure 14*.

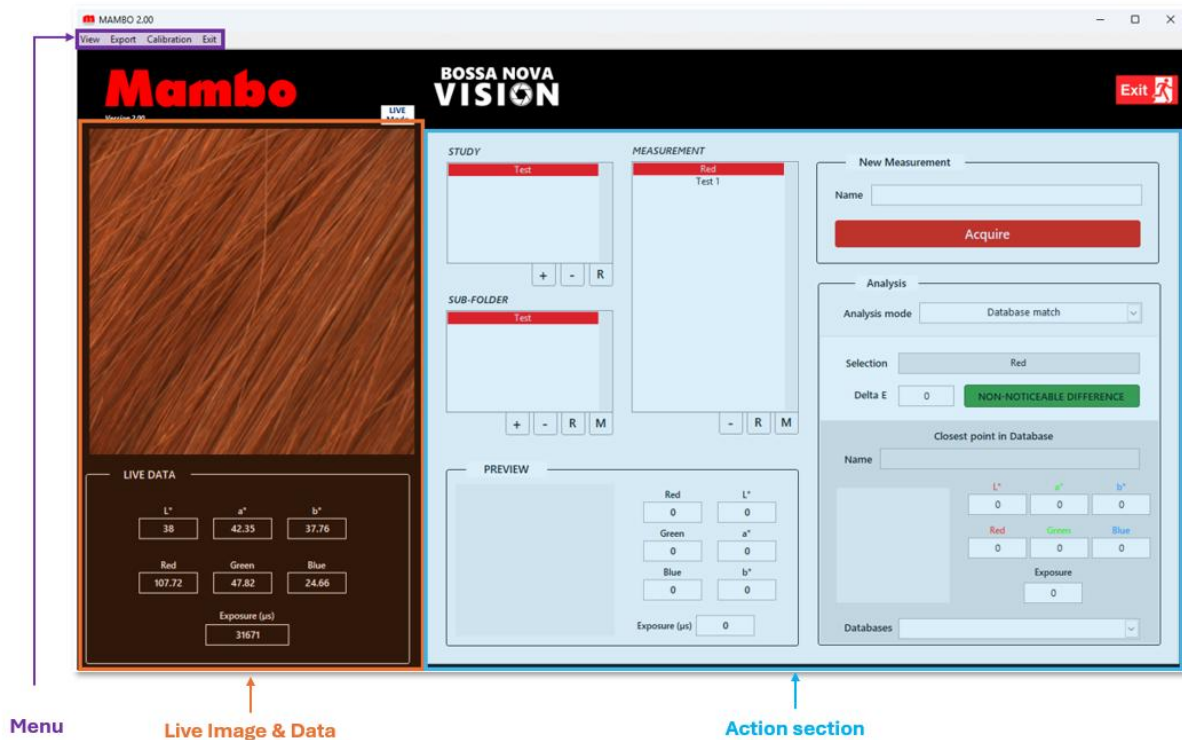


Figure 14 - Main Window

On the top of the window is the **Top menu** (2.2.1)

On the left side of the window is the **Live image & Live data** (2.2.2). This is only activated with the **Live measurement & load data** mode.

In the middle / right side of the window is the **Action** section, which can switch between different sections by using the **Top Menu** (2.2.1).

You also have an exit button on the top right corner of the window.

2.2.1. Top Menu

The top menu enables you to access the multiple sections of the software.

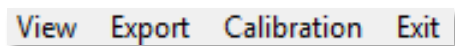


Figure 15 - Top menu

The different menus are:

- View:
 - Standard (2.3below)
 - Color Retention (2.4)
 - Database (2.5)
- Export:
 - Standard
 - Color Retention
- Calibration (Advanced User only):
 - Open Calibration tab (2.6)
 - Open Color Calibration tab (2.7)
 - Illumination Calibration
- Exit

2.2.2. Live image & Live data

The left side of the window consists of the live image visualization, the data associated with it, and a control/indicator Live or Load Mode (*Figure 16*).



Figure 16 - Control/Indicator of Live/Load mode

When **Live measurement & load data** is selected, the image shows the **live output of MAMBO**, the **RGB** and **L*a*b*** values of the average color of the image and the **exposure time** associated with the image acquisition (*Figure 17*).

If **Load data only** is selected, the display only shows a “**MAMBO – Load Only**” image.

If the user clicks on the indicator/control on the top right of the image, a pop-up window appears (*Figure 8*) asking the user to choose the operation mode similar to the start of the software.

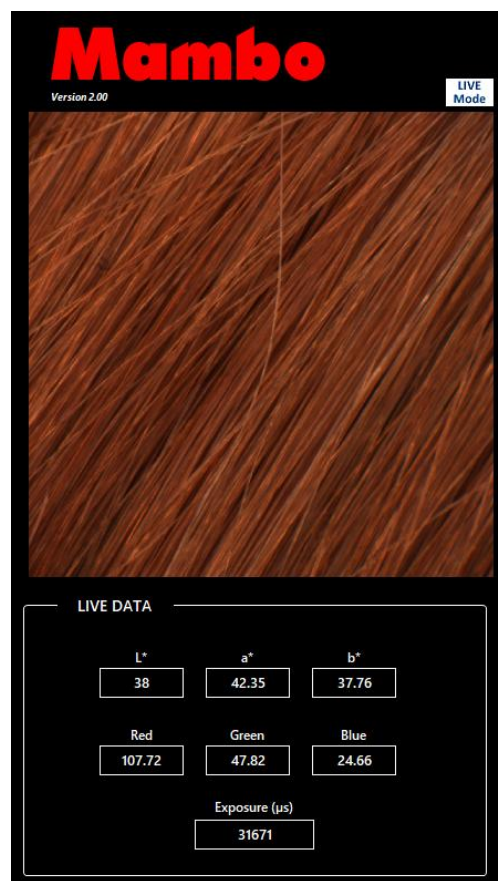


Figure 17 - Live image & Data

2.3. Standard section

While the top menu and the Top menu (2.2.1) and the Live image & Live data (2.2.2) are always visible, the middle section changes depending on the Action View you select from the Top Menu.

Upon starting the software, the section will be the standard section, but you have the option to use the Color Retention section, the Database section, as well as the Color Calibration and Camera Calibration sections for Advanced User.

In the standard section, you will have access to additional subsections (*Figure 18*):

- Data Management & Preview
- Acquisition
- Analysis

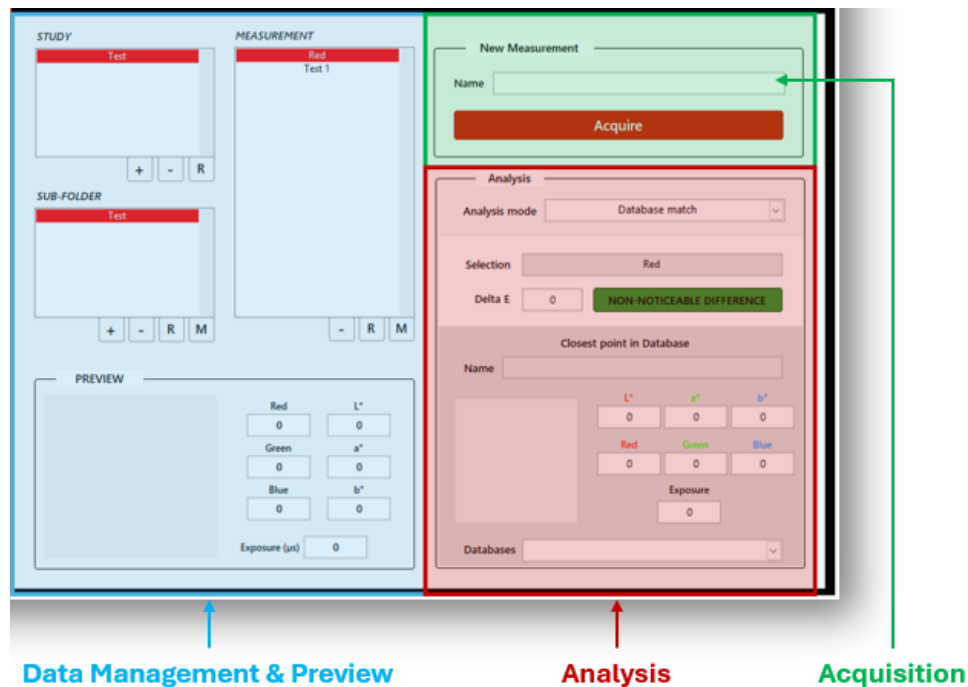


Figure 18 - Standard section

2.3.1. Data Management

The Data Management subsection allows the user to manage the data to be saved and processed (**Figure 19**). The user can create, delete, move and rename different folders and measurements.

3 lists are present: STUDY, SUB-FOLDER and MEASUREMENT. These correspond to lists of folders where the raw data / images are saved.

MEASUREMENTS are saved in a SUB-FOLDER, and SUB-FOLDERS are saved in a STUDY.

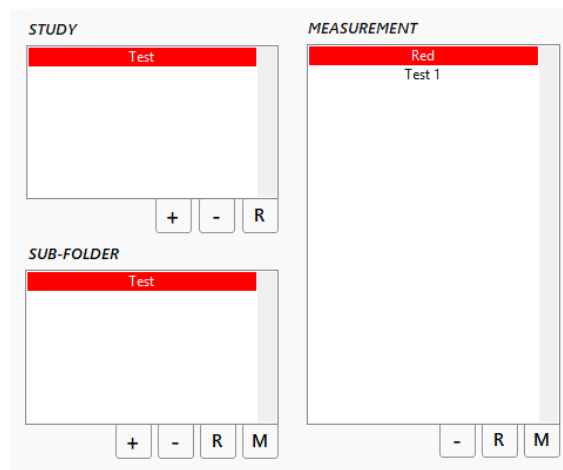


Figure 19 - Data management

Whenever you select a measurement, the measurement preview tab (**Data Preview**) and the analysis tab (**Standard measurements analysis**) are updated with the new measurement. Also, under each list is a set of controls you can click to activate several actions.

Create

Clicking on the plus (+) control triggers a pop-up window asking for the name of the new study or the new sub-folder you want to create (**Figure 20**).

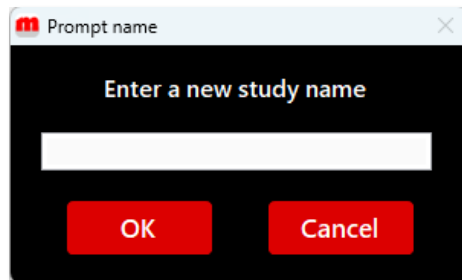


Figure 20 - Create Study / Sub-folder / Measurement

Clicking on the cancel control will cancel the creation of the new study or sub-folder and close the pop-up window

Delete

Clicking on the minus (-) control to delete a study, sub-folder or a measurement will trigger a pop-up window asking the user to confirm (**Figure 21**). You can select multiple studies, sub-folder and measurement by using CTRL + Left Click / ALT + Left Click.

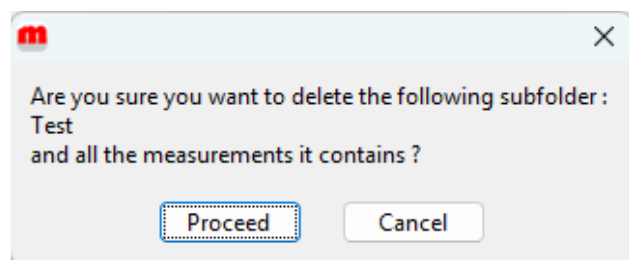


Figure 21- Delete Study / Sub-Folder / Measurement

Note that when a folder is deleted, everything it contains is also deleted. For example, if the user deletes a study folder, the sub-folders and measurements folder contained in the study will also be deleted.

Clicking on the cancel button will cancel the deletion process and close the pop-up window.

Rename

The user can rename a study, a sub-folder or a measurement. Clicking on the R control (**R**) triggers a pop-up window (**Figure 22**) to enter the new name

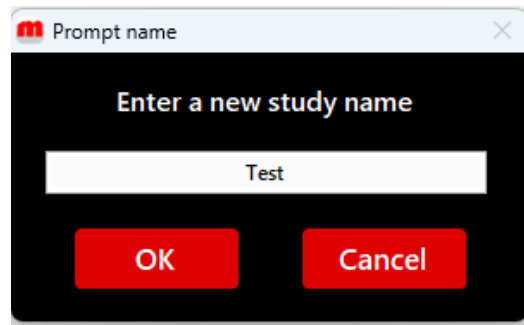


Figure 22- Rename Study / Sub-Folder / Measurement

Clicking on the cancel control will cancel the renaming of the study, sub-folder or measurement and close the pop-up window.

Move

The user can move a sub-folder (and all its contents) to a different study or move several measurements to a different sub-folder. Clicking on the M control (**M**) opens a pop-up window (*Figure 23*).

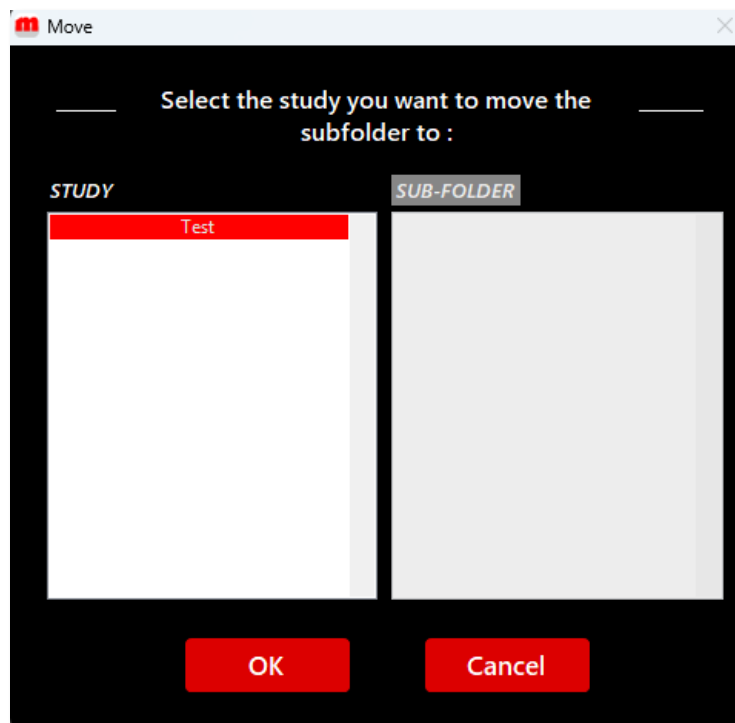


Figure 23- Move Sub-Folder / Measurement

Clicking on the cancel control will cancel the move of sub-folder or measurement and close the pop-up window.

2.3.2. Data Preview

The Data preview subsection displays the image and color information of the measurement previously selected in the **MEASUREMENT** list.

On the left is the image. You can copy the image to the Windows Clipboard by right-clicking on the image and clicking on **Copy to Clipboard**.

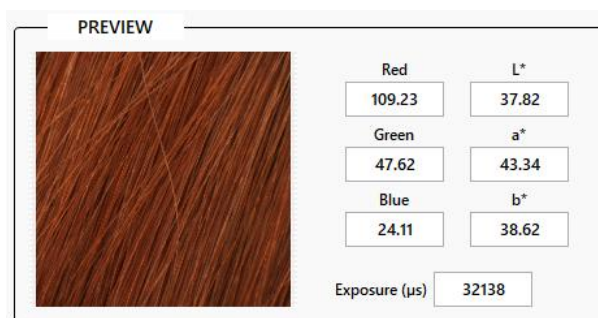


Figure 24 - Data Preview

On the right you can see:

- The Red, Green and Blue value of the RGB image, and the exposure time associated
- The L*a*b* color value calculated using the color calibration of the MAMBO

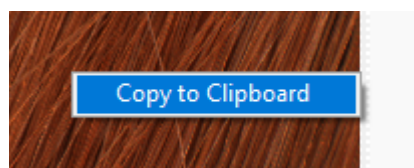


Figure 25- Image preview - Copy to Clipboard

2.3.3. Acquiring standard measurement

To acquire a new measurement, the software must be in live mode and the hardware test must have been completed successfully for the camera and the illumination.

In Load mode, the **Acquire** control is deactivated.

To acquire a new measurement, you only need to enter the name of the new measurement in the string control and click on **Acquire**.

If no study or sub-folder is selected, or if the name field is empty, the measurement cannot be completed and a pop-up window appears (Figure 27 / Figure 28).

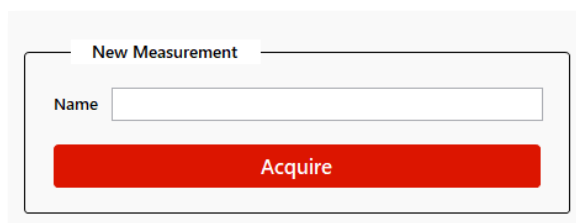


Figure 26 - Measurement acquisition

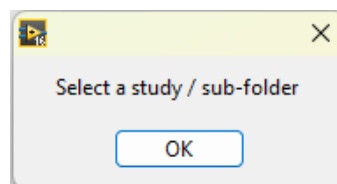


Figure 27 - No Study / Sub-folder selected

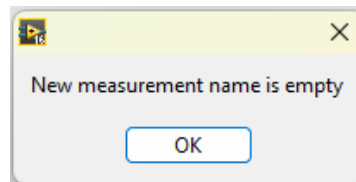


Figure 28 - No measurement name

2.3.4. Standard measurements analysis

Whenever you select a measurement, the analysis section is updated and will display data depending on the type of pre-selected analysis.

At the top of the analysis subsection, you have a menu allowing you to select what kind of analysis you want to be displayed. You have the choice between **Histogram**, **Single Measurement Comparison**, **Database match** and **Grey Hair analysis**

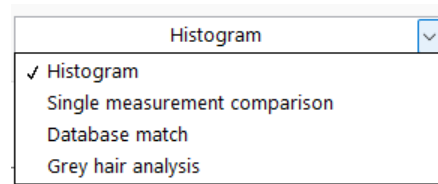


Figure 29 - Analysis selection

Histogram

The **Histogram** is a graph displaying the population distribution of red, green and blue pixel values in the original image.

The values are in the 0 to 255 range, so you also need to factor in the exposure time to calculate a value related to the actual intensity (in arbitrary units):

$$\frac{\text{Value (0 to 255)}}{\text{Exposure time}} = \text{Intensity (u. a.)}$$

If you want to compare measurements with one another, you need to use the intensity, and not the value of the histogram.

To export the histogram data, you can right-click on the graph and select **Export > Export to Clipboard / Excel**.

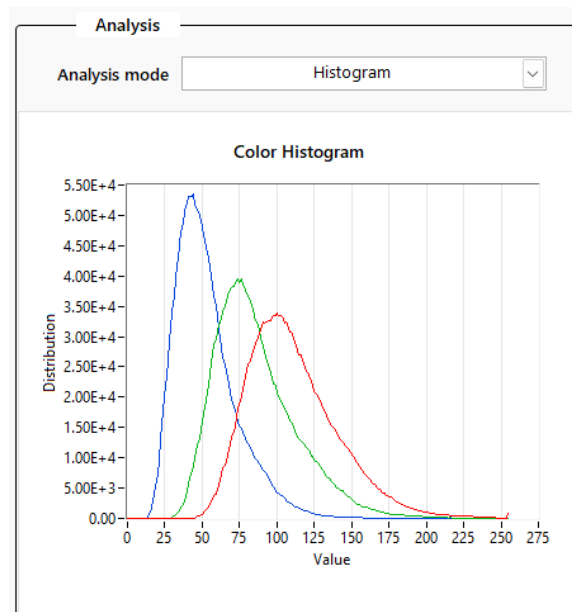


Figure 30 - Histogram

Single Measurement Comparison

The **Single Measurement comparison** analysis compares the color values from a reference measurement to the color values of the measurement currently selected from the **MEASUREMENT** list.

To change the reference measurement, select a measurement in the **MEASUREMENT** list, and click on the **Select current selection as reference** control (Figure 31 - Select reference control).

Select current selection as reference

Figure 31 - Select reference control

Analysis

Analysis mode: Single measurement comparison

Selection: 6NG

Delta E: 10.62 NOTICEABLE DIFFERENCE

Reference data

Reference image: [Wood texture image]

Color values:

L*	a*	b*
37.28	10.03	21.55
Red: 83.96	Green: 63.7	Blue: 42.29

Exposure: 34252

Select current selection as reference

Reference: 6Y

Figure 32 - Measurement comparison

The reference data block is then populated with a preview of the reference image and the color values associated with it (Figure 32 - Measurement comparison).

Whenever you select a new measurement in the **MEASUREMENT** list, it get automatically compared to your reference measurement and provide you with the data in the preview section, and a Delta E* value () in the comparison analysis section (Figure 32 - Measurement comparison).

Database Match

The **Database match** analysis compares the color values from a previously built database (**Database creation and management window**) to the color values of the measurement currently selected from the **MEASUREMENT** list.

To change the database, select one from the **Databases** selection menu.

Analysis

Analysis mode: Database match

Selection: test5

Delta E: 8.59 NOTICEABLE DIFFERENCE

Closest point in Database

Name: 8C

Reference image: [Wood texture image]

Color values:

L*	a*	b*
34.11	37.12	28.58
Red: 118.49	Green: 57.84	Blue: 43

Exposure: 32812

Databases: PM XG

Figure 33 - Database Match & Comparison

Whenever you select a new measurement in the **MEASUREMENT** list, it:

- compares its color values to the color values of all the measurements in the database
- identify the closest color in your database by comparing Delta E values (smallest difference is the closest color), display the closest color name, and the corresponding Delta E value
- display the color values and image of the closest image in the database

Grey hair analysis

The **Grey hair** analysis provides an estimate of the percentage of grey / white hair detected on the image of the measurement currently selected from the **MEASUREMENT** list.

While this analysis will provide a number for all measurements, the estimate is **only valid on dark swatches with white/grey hair**.

N.B. The estimate is only done on the image saved with the MAMBO. To get a more accurate estimate on a complete swatch, it is advised to do multiples grey hair % measurements at different positions of the same swatch.

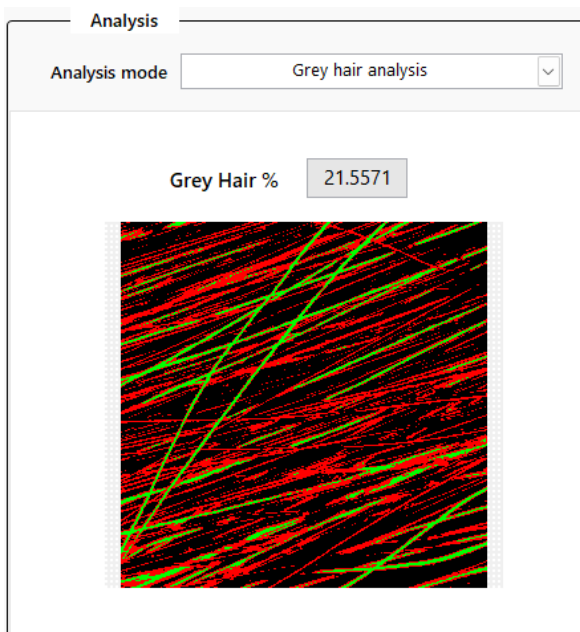


Figure 34 - Grey Hair analysis

2.4. Color Retention window

When you select **View > Color Retention** in the Top menu (2.2.1), the center action section will switch to the Color Retention window (**Figure 35 - Color Retention window**).

Figure 35 - Color Retention window

2.4.1. Color Retention study

The color retention study is a guided measurement process which is structured as follows:

- the swatches you will be using will all be identified by a unique name
- each swatch is segmented into:
 - 2 orientations: **Front** and **Back**
 - 3 positions: **Root**, **Middle** and **Tip**for a total of 6 different measurements per swatch
- your swatches will be separated into unique **Groups**
- you are going to segment your study into **Events**, which can represent a succession of processes (like a number of washes), a time (number of hours after the application of product), a mix of the two, or any arbitrary event pertinent to your study
-

Example of color retention study (study structure)

Aim of study: Measure the effectiveness of color protection of 2 shampoos

Your 3 example groups are going to be Water, Shampoo 1, Shampoo 2

We usually advise for a minimum of 3 swatches per group, so that there will be a total of 9 swatches.

For the events, an example would be to use the following 6 events, with the corresponding groups and swatches:

- **Event #1: No process**

Water	Shampoo 1	Shampoo 2
SW1	SW4	SW7
SW2	SW5	SW8
SW3	SW6	SW9

- **Event #2: Dye Application**

Water	Shampoo 1	Shampoo 2
SW1	SW4	SW7
SW2	SW5	SW8
SW3	SW6	SW9

- **Event #3: Wash #1** (with product corresponding to group)

Water	Shampoo 1	Shampoo 2
SW1	SW4	SW7
SW2	SW5	SW8
SW3	SW6	SW9

- **Event #4: Wash #2** (with product corresponding to group)

Water	Shampoo 1	Shampoo 2
SW1	SW4	SW7
SW2	SW5	SW8
SW3	SW6	SW9

- **Event #5: Wash #4** (with product corresponding to group)

Water	Shampoo 1	Shampoo 2
SW1	SW4	SW7
SW2	SW5	SW8
SW3	SW6	SW9

- **Event #6: Wash #8** (with product corresponding to group)

Water	Shampoo 1	Shampoo 2
SW1	SW4	SW7
SW2	SW5	SW8
SW3	SW6	SW9

In this example, we have a total of 9 swatches over 6 events, which results in 54 Data points. Each data point is composed of 6 Measurements, for a total of 324 MAMBO measurements.

2.4.2. Create / Delete / Select a study

Select a study

You can select what study you want to work with by selecting the corresponding study in the menu at the top of the color retention section (**Figure 36 - Study selection**).

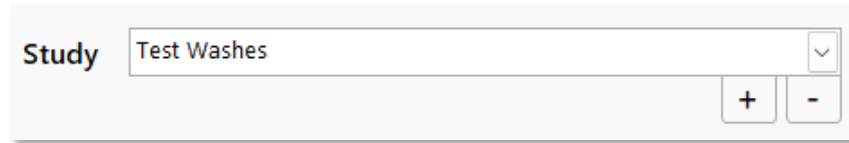


Figure 36 - Study selection

Create a study

If you need to create a study, you need to click on the + control, and a new window will appear (**Figure 37 - Create new study**). In this window, you will detail all the parameters of the study you want to create.

The first step is to provide a study name, which you can do by typing in a new name in the control at the top of the window.

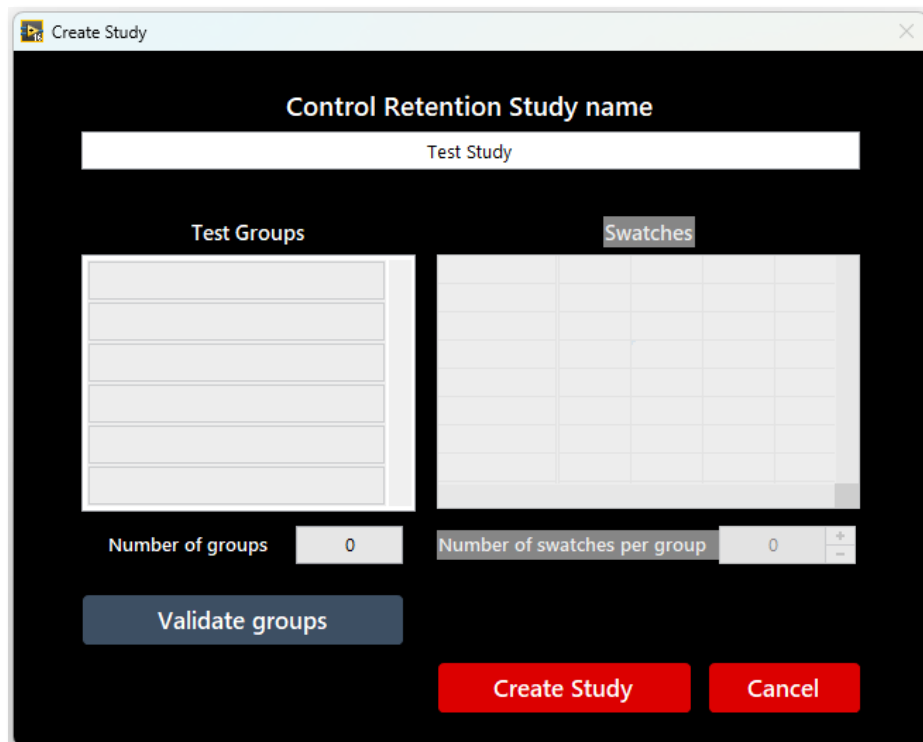


Figure 37 - Create new study

Then you need to define your groups. For this, you need to type the name of the different groups you want in the **Groups** array on the left side of the window (**Figure 38 - Groups creation**).

The **Number of groups** indicator will automatically update with the number of groups you've set up.

Once you're done with the Groups, you can click on the **Validate groups** control to proceed with the Swatches selection (**Figure 39 - Swatches selection**). The control name will change to **Edit groups**.

For the next step, you first need to decide on the number of swatches using the **Number of swatches per group** control. The table of swatches name will auto-populate with names in the format **SWXX**. You can change the name by selecting the names in the cell and typing in new names.

If you need to change the groups again, you can click on the **Edit Groups** control and start the process over.

Once you have set everything up properly, you can then click on the **Create Study** control (**Figure 40 - Create Study control**).

Groups

Water
Shampoo 1
Shampoo 2

Number of groups: 3

Validate groups

Figure 38 - Groups creation

Swatches

Water	SW1	SW2	SW3	
Shampoo 1	SW4	SW5	SW6	
Shampoo 2	SW7	SW8	SW9	

Number of swatches per group: 3

Create Study

Figure 39 - Swatches selection

Create Study

Figure 40 - Create Study control

Groups and Swatches lists

Once a study has been selected, the list for the groups will be filled with the names previously configured for the study.

When you select a group, the list for the swatches will be filled with the names corresponding to the group selected.

- Incomplete groups/swatches will appear in red, bold, and italic font
- Completed groups/swatches will appear in plain black font

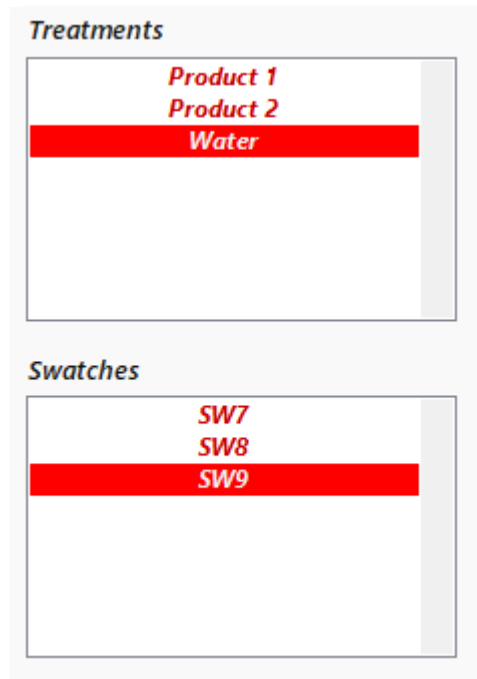


Figure 41 - Groups and Swatches lists

Delete a study

To delete a study, simply click on the (–) button under the study selection menu. A window will pop-up to confirm (Figure 42 - Delete study).

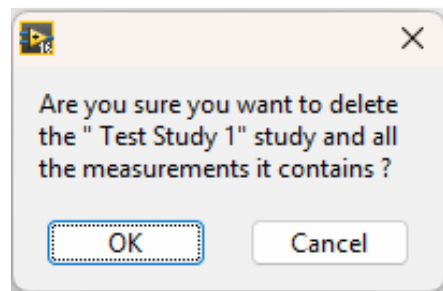


Figure 42 - Delete study

Click on OK to delete the study.

Be careful, deleting the study will also delete all the measurements contained in the study. Deleting a study is final and is not recoverable.

2.4.3. Create / Delete / Organize events

On the left side of the color retention section is the **Events** list (**Figure 43 - Events list**).

- Incomplete events will appear in red, bold and italic font
- Completed events will appear in plain black font

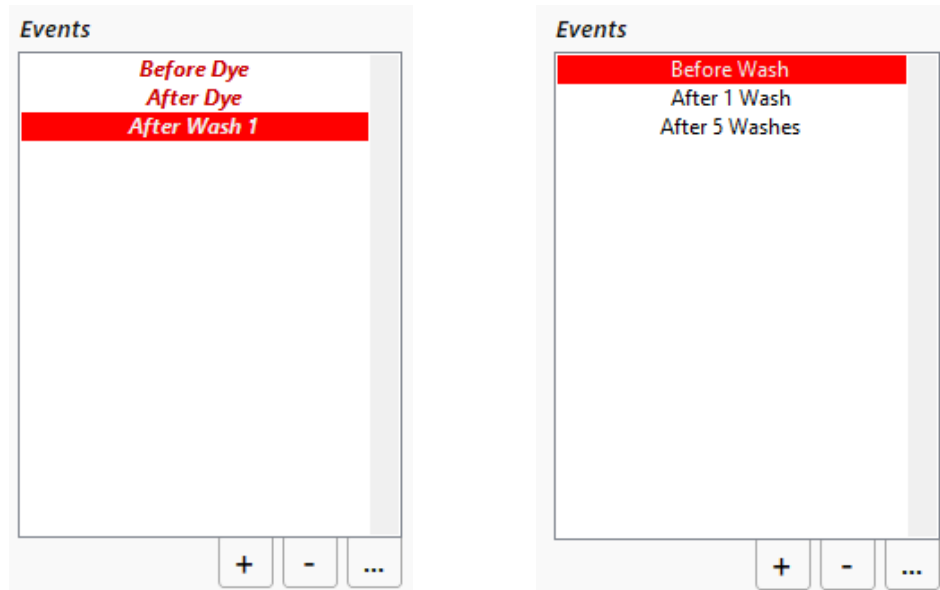


Figure 43 - Events list (incomplete)

Create an event

If you want to create an event, you can click on the + control at the bottom of the event list and a new window will appear (**Figure 44 - Event creation**). In this window, you will detail all the parameters of the event you want to create.

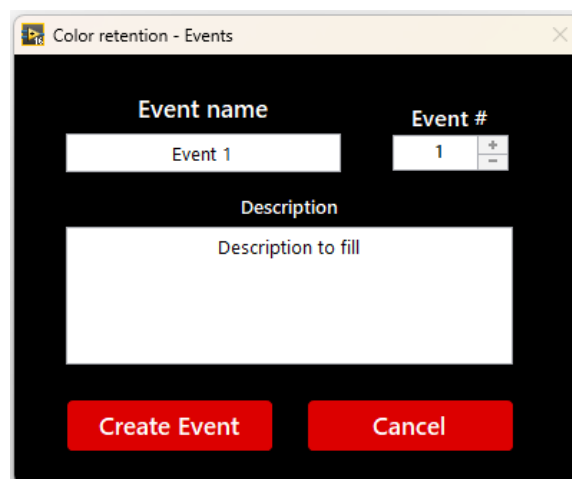


Figure 44 - Event creation

The first step is to provide a **name** for your event, which you can do by typing in a new name in the control at the top left of the window. You also have to provide an **event number** which is used to order your events in the correct chronological order. You also have an option to fill in a **description** for your event.

To finalize the process, click on the “Create Event” control.

Delete an event

To delete an event, simply click on the (–) button under the event selection menu. A window will pop up to confirm (Figure 45 - Deleting an event window).

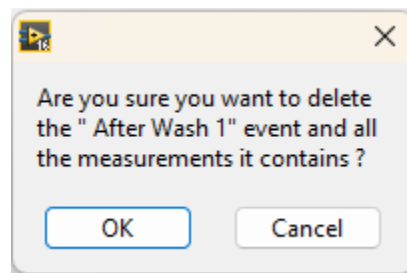


Figure 45 - Deleting an event window

Click on OK to delete the event.

Be careful, deleting the event will also delete all the measurements contained in the event. Deleting an event is final and is not recoverable.

Edit an event

You can also edit an event, if you wish to change the name of the event, change the order of your events or modify the description associated with the event.

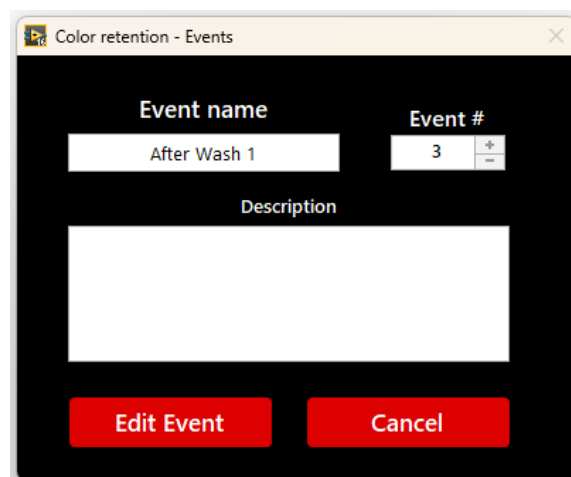
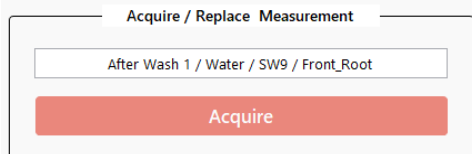


Figure 46 - Edit an event

2.4.4. Color retention measurements acquisition

To acquire a new measurement for a color retention study, the software must be in live mode, and the hardware test must have been completed successfully for the camera and the illumination. Otherwise, the acquire control be de-activated



(**Figure 48 - Deactivated Acquire control**)

You first need to select the parameters of the measurement you want to take in the corresponding lists (**Events**, **Groups**, and **Swatches**).

You also need to select the proper **Orientation** and **Position** of the current measurement. This is done by clicking on the corresponding control next to the image of the swatch (**Figure 47 - Select Orientation / Position**).

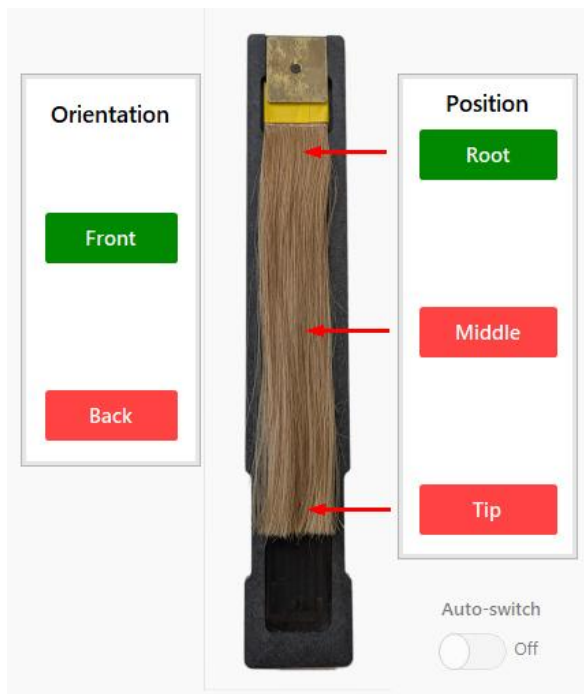


Figure 47 - Select Orientation / Position

In the Acquire / Replacement Measurement section, the name indicator will automatically be filled with the parameters you selected. From there, there are several options:

- If the measurement doesn't exist, you can acquire a new measurement by clicking on **Acquire** (**Figure 49 - Activated Acquire control**)
- If the measurement already exists, the control will display a **Replace** control instead of **Acquire** (**Figure 50 - Replace control**). You can replace the measurement by clicking on **Replace**. A

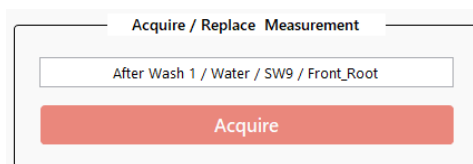


Figure 48 - Deactivated Acquire control

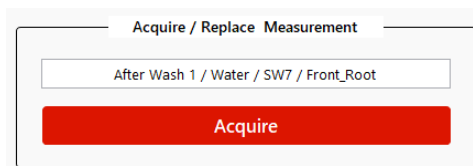


Figure 49 - Activated Acquire control

pop-up window will ask you to confirm as the previous measurement will be overwritten by the new one

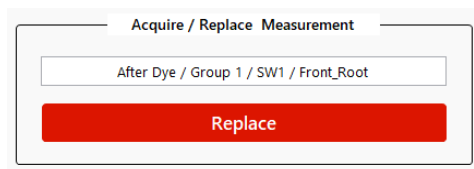


Figure 50 - Replace control

The last control available on the color retention section is the Auto-Switch (**Figure 51 - Auto-switch control**).

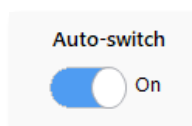


Figure 51 - Auto-switch control

When turned on, the parameters will automatically change after each acquisition in the following order (left to right) :

Front			Back			Front ...
Root	Middle	Tip	Root	Middle	Tip	Root ...

Table 2 - Order of auto-switch

The auto-switch will not affect the selection of Events, Groups or Swatches. The user will still have to manually change these parameters if it is required.

2.4.5. Color retention measurements preview

If you select a set of parameters (Event, Groups, Swatches, Position, Orientation), the software will display some information (**Figure 52 - Color retention status preview**)

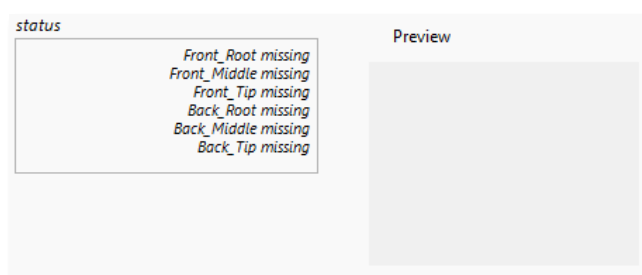


Figure 52 - Color retention status preview

In the status window, the software will display if some positions and orientations are missing for the selected Event, Group and Swatch. If the Position and Orientation match an existing measurement, a preview of the measurement image will appear (**Figure 53 - Color retention image preview**).

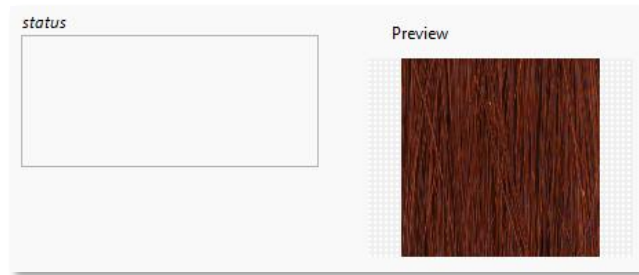


Figure 53 - Color retention image preview

2.4.6. Color Retention analysis

The MAMBO software can provide a preliminary analysis of your color retention study by opening the color retention analysis window.

Opening the Color Retention analysis

To open the color retention analysis window, you need to click on the Color Retention Analysis control (Figure 54 - Color Retention Analysis control).



Figure 54 - Color Retention Analysis control

If you haven't completed all the measurements in your study (i.e. there are still incomplete events), a window will pop up (Figure 55 - Incomplete events window) asking if you still want to go forward with the analysis. If you decide to proceed, the analysis will only include the completed events.

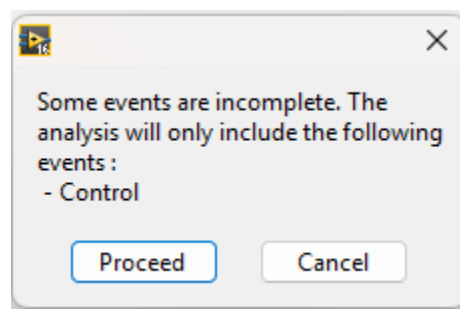


Figure 55 - Incomplete events window

Once the analysis has started, a progress bar will be displayed (Figure 56 - Color Retention progress bar).

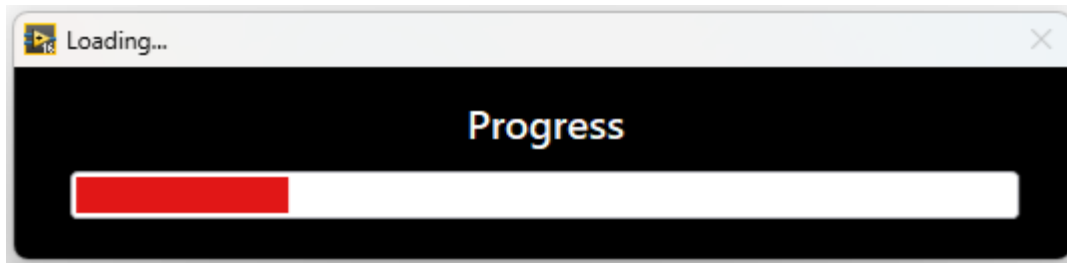


Figure 56 - Color Retention progress bar

Once all measurements have been processed, the Color retention analysis window will be displayed.

Color retention analysis window

The Color retention analysis window (Figure 57 - Color Retention analysis window) provides graphs and data organized according to the parameters (events, groups, swatches) you selected for your study.

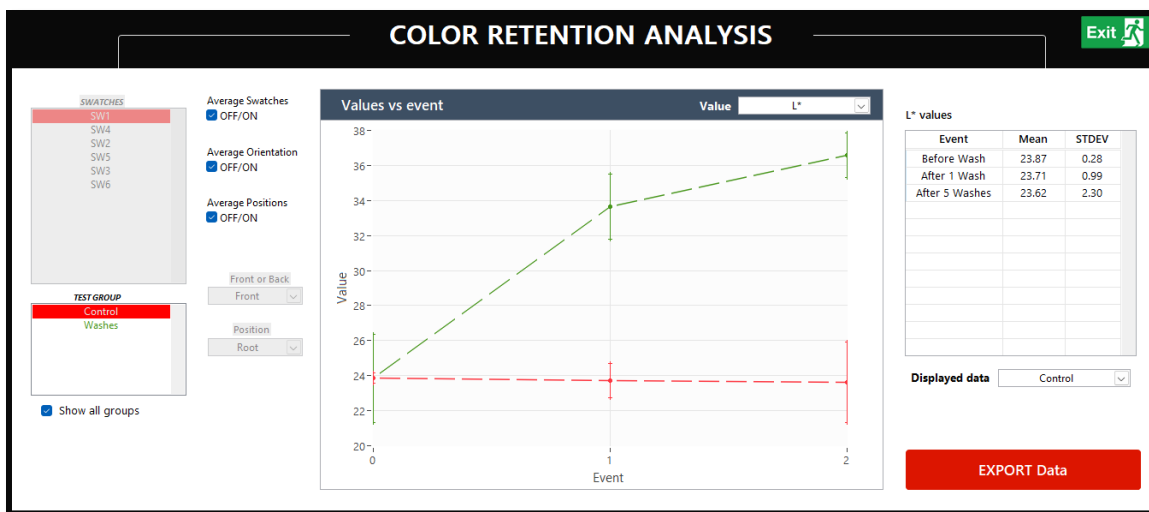


Figure 57 - Color Retention analysis window

In the center of the window is the main graph (Figure 58 - Color analysis graph).

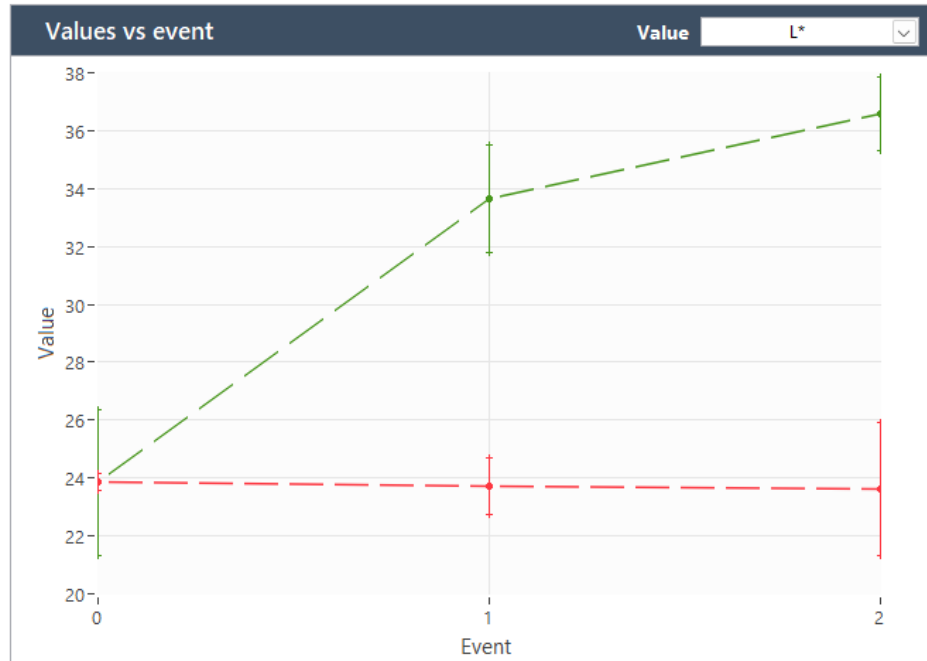


Figure 58 - Color analysis graph

The X-axis will be the succession of events.

On the Y-axis, the graph will display one of the parameters and its standard deviation.

The user can change this parameter by selecting a new one in the **Value** selection menu at the top right corner of the graph (

Figure 59 - Value selection menu).

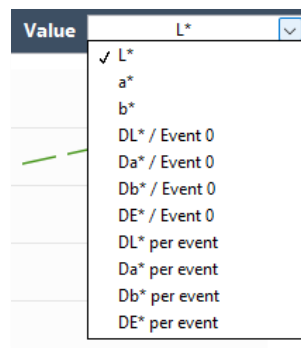


Figure 59 - Value selection menu

The L^* , a^* and b^* values are the same values usually displayed when you preview a measurement. The DL^* / Da^* / Db^* / DE^* corresponds to the distance between the measurement and a reference. From this menu, you can select the reference as:

- The first event (or Event 0)
- The previous event

On the right side of the window is a table (Figure 60 - Color Analysis table) that contains the same data displayed in the graph, separated between the Average value (as **Mean**) and the Error (as **STDEV**).

If multiple groups are displayed in the graph, you can select which group will be shown in the table using the **Displayed data** menu under the **Values** table (Figure 60 - Color Analysis table).

You can also directly copy the table values into the Clipboard by right-clicking on the table and selecting **Copy Data to Clipboard** (Figure 61 - Copy Table to Clipboard).

You can then directly paste (CTRL + V) these values directly into a text file or a spreadsheet.

L* values

Event	Mean	STDEV
Before Wash	23.87	0.28
After 1 Wash	23.71	0.99
After 5 Washes	23.62	2.30

Displayed data Control Control Washes

Figure 60 - Color Analysis table

Event	Mean	STDEV
Before Wash	23.87	0.28
After 1 Wash	23.71	0.99
After 5 Washes	23.62	2.30

Copy Data to Clipboard

Figure 61 - Copy Table to Clipboard

On the left side of the window, you can select what sets of measurements are displayed in the graph / table:

- You can select the **Position** (Root / Middle / Tip) to display, or select **Average Positions** to display an average value of all positions
- You can select the **Orientation** (Front / Back) to display, or select **Average Orientation** to display an average value of all orientations
- You can select the **Swatch** to display, or select **Average Swatches** to display the average value of all swatches from the same groups and select the group

SWATCHES

SW1

SW4

SW2

SW5

SW3

SW6

Average Swatches

☒ OFF/ON

Average Orientation

☒ OFF/ON

Average Positions

☒ OFF/ON

Front or Back

Front

Position

Root

TEST GROUP

Control

Washes

☒ Show all groups

Figure 62 - Color retention analysis display options

to display from the TEST GROUP list

If you select **Average Swatches**, the **Swatches** list will be grayed and disabled, and you will be able to select a Group instead. You can also select the **Show all groups** option to display all groups in a single graph instead of a single group.

Finally, you can export the data from your Color retention study to a text file using the EXPORT Data button (**Figure 63 - Export Data control**) located in the bottom right corner of the window.



Figure 63 - Export Data control

More details on the data exported are available in the section **2.10 Color Retention Export**.

2.5. Database creation and management window

A database is a collection of pre-processed measurements, providing reference $L^*a^*b^*$ values you can then use to compare your measurements with.

You can access the Database creation and management section through the Top Menu > View > Database. The section below will be displayed in the interface (**Figure 64 - Database creation and management section**).

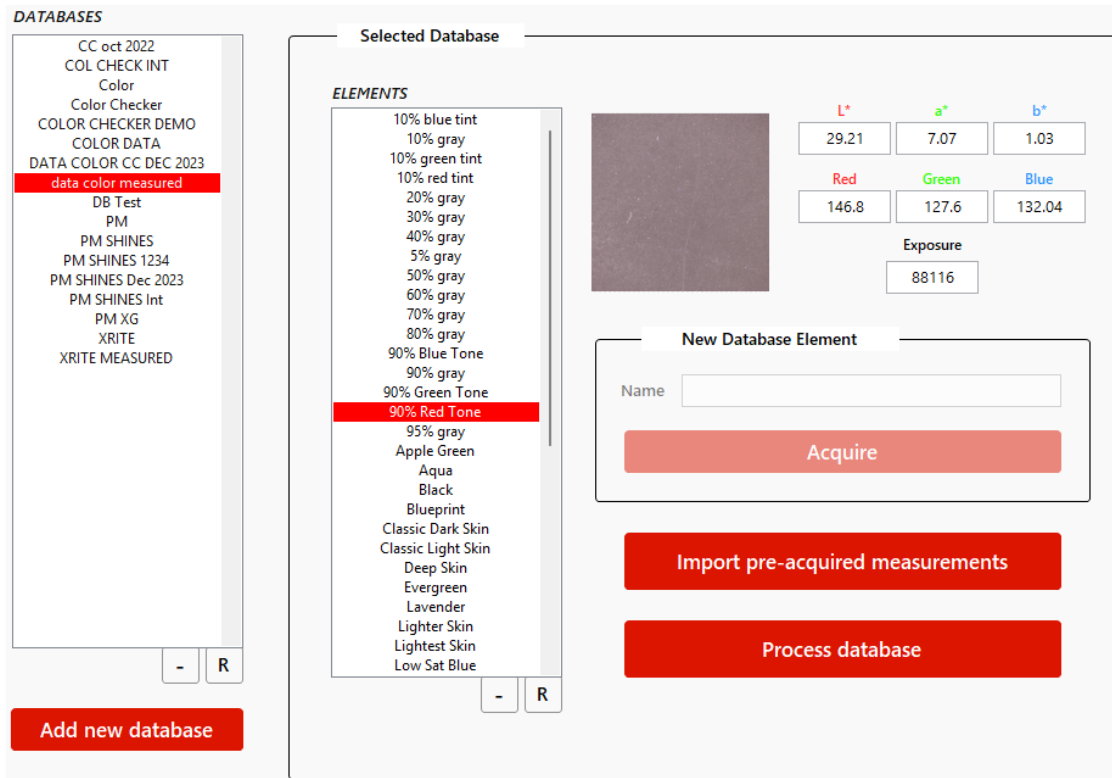


Figure 64 - Database creation and management section

2.5.1. Create / Delete / Rename databases

On the left side of the window is the list of all the database previously created. It is also from this part that you can create, delete or rename databases

Create a new database

You can create a new database by clicking on the control **Add new database** (Figure 65 - Add database control) under the database list.

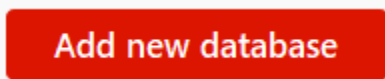


Figure 65 - Add database control

A prompt window will appear (Figure 66 - Enter database name window). You need to enter a new database name and click on **OK** to complete the database creation process. Clicking on the **Cancel** control will cancel the renaming of the database and close the pop-up window.

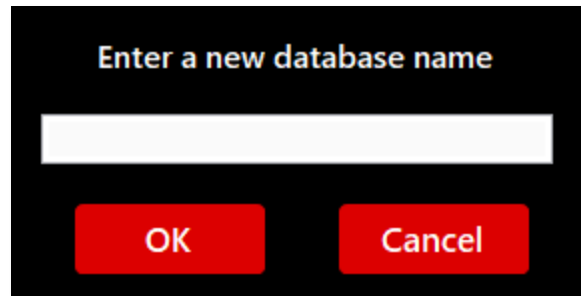


Figure 66 - Enter database name window

You will need to add elements to this database, and the process for this is detailed later in this manual.

Rename a database

The user can rename a database. Clicking on the R control (R) under the database list triggers a pop-up window (Figure 66 - Enter database name window) to enter the new name, similar to the window of the database creation process.

Clicking on the cancel control will cancel the renaming of the database and close the pop-up window.

Delete a database

To delete a database, simply click on the (–) button under the database list. A window will pop up to confirm (Figure 67 - Deleting a Database).

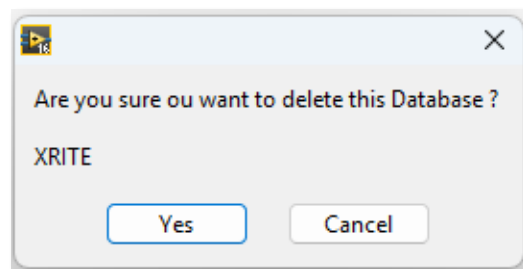


Figure 67 - Deleting a Database

Click on **Yes** to delete the database.

Be careful, deleting the database will also delete all the elements contained in the database. Deleting a database is final and is not recoverable.

2.5.2. Add elements to database

At the creation of the database, it will not contain any elements. To do so, you must either:

- **acquire** new elements
- or **import** them from existing measurements

You can see the current list of elements in a database by selecting a database and looking at the element list in the **Select Database** section (**Figure 68 - Element list**).

You can rename or delete any element in the database

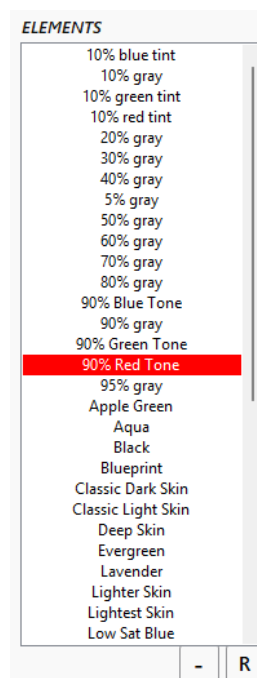


Figure 68 - Element list

Acquire new elements

The acquisition of new elements works the same as acquiring new standards measurements. It can only be done in **Live mode**.

First, you need to select the database in which you want to add measurements to. Then, similar to how you would acquire a new measurement, you can acquire a new element by typing in the name of your element in the appropriate indicator and click on **Acquire** (**Figure 69 - Acquire a new database element**).

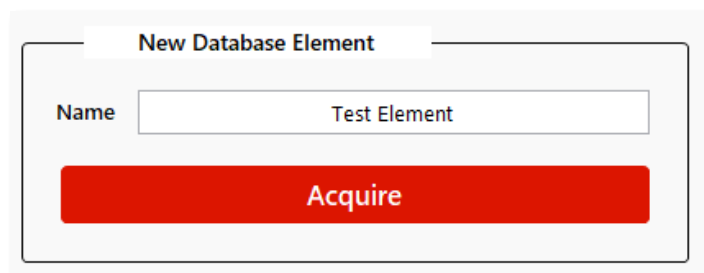


Figure 69 - Acquire a new database element

The database element will then be added to the list.

Import existing measurements

Instead of acquiring new elements, you can also import them from pre-existing measurements. You can do so in both **Live mode** and **Load mode**.

To import, click on the **Import pre-acquired measurements** control (Figure 70 - Import elements to database).

Import pre-acquired measurements

Figure 70 - Import elements to database

This will open a new window in which you will be able to select measurements and import them all in one block (Figure 71 - Import elements window).

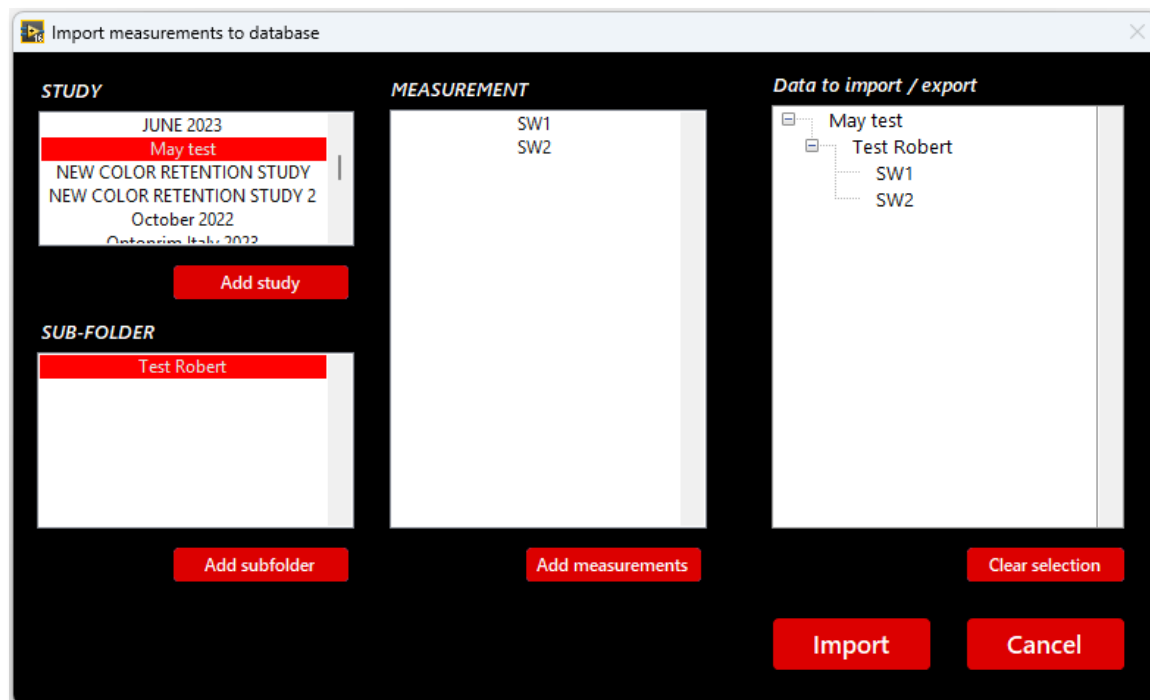


Figure 71 - Import elements window

You can use **Add study**, **Add subfolder** and **Add measurements** to respectively add one study, one subfolder or multiple measurements to the list **Data to import / export**. You can also use the **Clear selection** control the empty the same list.

Once you have finished the list, you can click on **Import** to copy those measurements into elements for your database or **Cancel** to abort the import process.

Rename database elements

The user can rename an element. Clicking on the R control (**R**) under the element list triggers a pop-up window (Figure 72 - Rename a database element) to enter the new name.

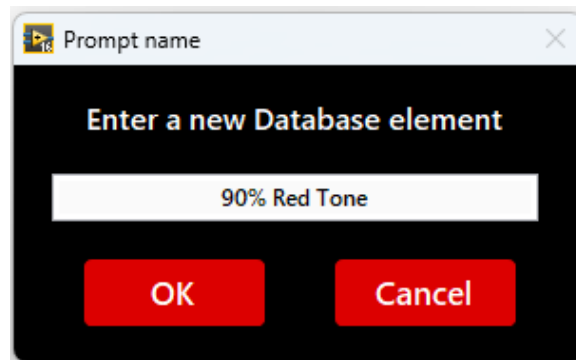


Figure 72 - Rename a database element

Clicking on the **Cancel** control will cancel the renaming of the database and close the pop-up window.

Delete database elements

To delete an element from a database, simply click on the (–) button under the element list. A window will pop up to confirm (**Figure 73 - Delete a database element**).

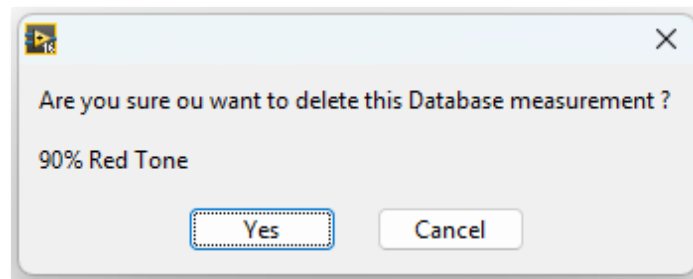


Figure 73 - Delete a database element

Click on **Yes** to delete the element.

Be careful, deleting a database element is final and is not recoverable.

2.5.3. Database elements preview

When selecting an element in the element list, the Preview element section (**Figure 74 - Preview database element**) will display the image and color information of the element, similarly to the preview section for standard measurements.



Figure 74 - Preview database element

The information includes an image preview, RGB values, exposure time and corresponding L*a*b* values.

2.5.4. Processing the database

Before being able to use the database for comparisons with standard measurements, the database needs to be processed. The processing needs to be done:

- Whenever you add an element to the database
- Whenever you rename an element of the database
- Whenever you delete an element of the database
- Whenever you change the color calibration

To start processing a database, click on the **Process database** control (**Figure 75 - Process database control**).

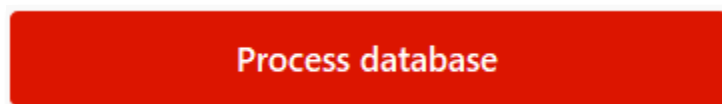


Figure 75 - Process database control

If the database has never been processed before, the processing will automatically start.

If the database had been processed in the past, a pop-window will ask if you wish to re-calculate all parameters, only the missing items, or if you wish to cancel the processing (**Figure 76 - Window for database processing confirmation**).

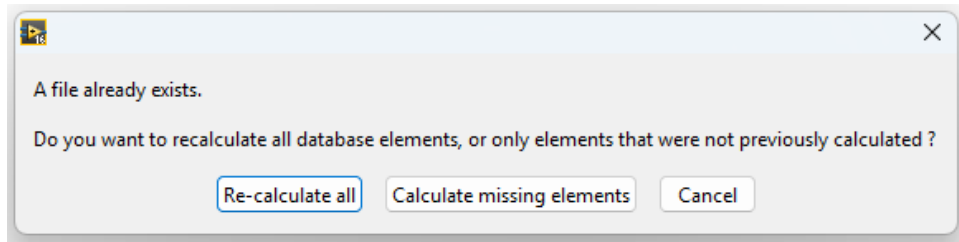


Figure 76 - Window for database processing confirmation

Calculating missing elements is pertinent only if you add new elements to the database. If you wish to calculate missing elements, but all elements are accounted for in the processing file, a window will tell you that all elements are already calculated (**Figure 77 - All elements calculated**).

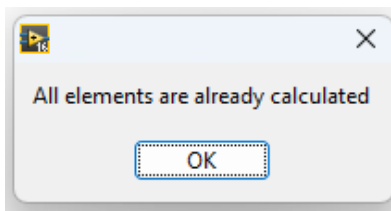


Figure 77 - All elements calculated

If you renamed an element, deleted an element or modified the color calibration, you must re-calculate all elements.

2.6. Calibration Window (Advanced user)

This calibration process will affect the measurements acquired with the MAMBO. This part of the software is usually greyed out and inaccessible, unless a BOSSA NOVA Vision employee provides **Advanced User** access to your MAMBO software.

If you want to conduct a new camera calibration of your system, please read ahead and carefully follow the guidelines below.

In case there is any doubt about the process, please contact a BOSSA NOVA Vision employee through our website at:

<https://www.bossanovavision.com/homepage/contact-us/>

or reach out using the email address info@bossanovavision.com

You can access the Camera Calibration section through the **Top Menu > Calibration > Open Calibration tab**. This can only be accessed as an **Advanced user** in **Live Mode**.

When accessing this section, the live image section – on the left side of the window – will be deactivated, and the calibration section will be displayed (**Figure 78 - Camera calibration section**).

It consists of:

- The **uncropped image** from the camera
- The **color histogram** from the Region Of Interest (ROI)
- 5 sections corresponding to 5 different calibrations that can be done on the camera:
 - **X / Y adjustment** to modify the size and position of the ROI
 - **Exposure** to adjust the reference exposure level of the camera
 - **White balance** to adjust the balance between the camera color channels
 - **Flat field image** to correct the inhomogeneity in the illumination
 - **Offset image** to adjust black and offset levels of the camera

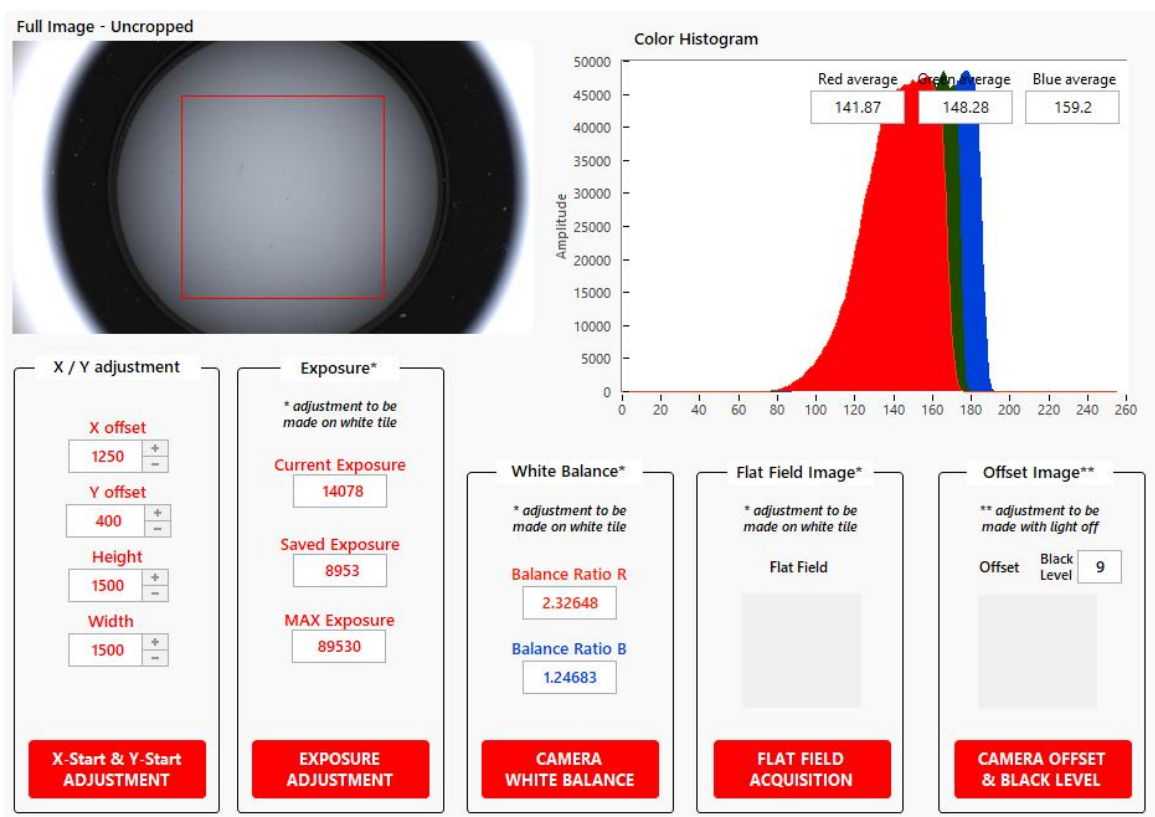


Figure 78 - Camera calibration section

For a complete calibration (all 5 steps), it is advised to complete the processing in the left to right order.

Several of these adjustments need to be made on the **Color Checker White tile** (Figure 79 - Color Check White tile).

White tile to be used for camera calibration



Figure 79 - Color Check White tile

These adjustments **must not be made on the MAMBO support** used for the illumination check.

For the steps that need to be done on the white tile, a pop-up window will appear to confirm you have put the MAMBO on the white tile. You can then proceed with the calibration or cancel (Figure 80 - Window to confirm placement on white tile).

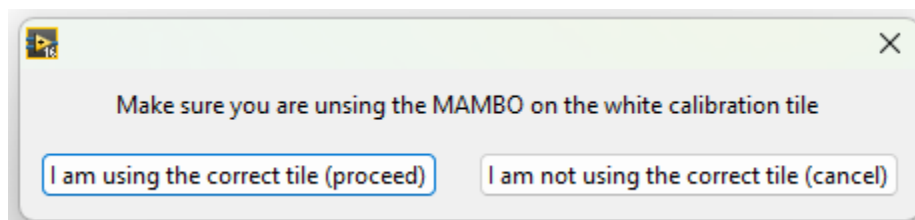


Figure 80 - Window to confirm placement on white tile

If you decide to cancel, a new window will be displayed to confirm that the calibration has been aborted.

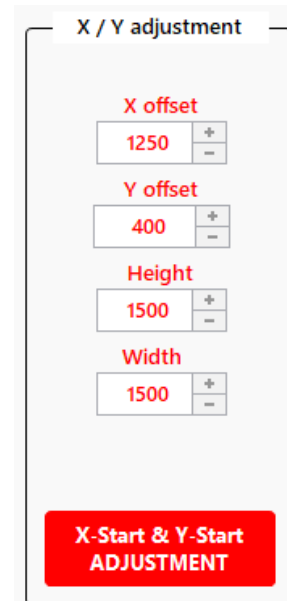
2.6.1. X / Y adjustment

This adjustment modifies the size and position of the Region of Interest (ROI), visible as a red square on the uncropped image. The MAMBO software uses that ROI to determine the region of the image the measurement is conducted on.

You can manually adjust the **X and Y offset** so that the ROI is properly centered on the sample, and that no edge is in the ROI.

Height and **Width** should be kept at 1500 to keep the same ROI dimensions, but it is possible to change these, if required.

Once you have adjusted the ROI size and position, click on **X-Start & Y-Start ADJUSTMENT** control to save these settings.



X / Y adjustment

X offset
1250

Y offset
400

Height
1500

Width
1500

X-Start & Y-Start
ADJUSTMENT

Figure 81 - X / Y Adjustment section

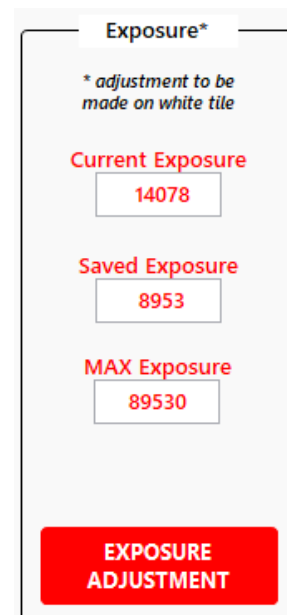
2.6.2. Exposure

The exposure adjustment measures an exposure time reference to calculate the range of exposure times available to the camera for its auto-exposure setting.

This calibration needs to be done on the color checker white tile.

The section will display the current **Saved** and **MAX exposure**, as well as the **Current Exposure** automatically calculated by the software.

Once the MAMBO is positioned on the white tile and the **Current exposure** has been automatically calculated, you can click on **Exposure Adjustment** to save these settings.



Exposure*

* adjustment to be made on white tile

Current Exposure
14078

Saved Exposure
8953

MAX Exposure
89530

EXPOSURE
ADJUSTMENT

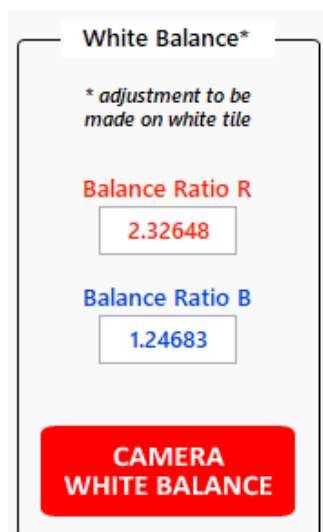
Figure 82 - Exposure Adjustment section

2.6.3. White Balance

The White balance adjustment measures the Balance ratios for the Red and Blue channel so that the Red, Green and Blue channels are level on a white target.

This calibration needs to be done on the color checker white tile.

Once the MAMBO is positioned on the white tile, you can click on **Camera White Balance** to start the calibration process. The new parameters will be saved automatically.



White Balance*

** adjustment to be made on white tile*

Balance Ratio R

2.32648

Balance Ratio B

1.24683

CAMERA WHITE BALANCE

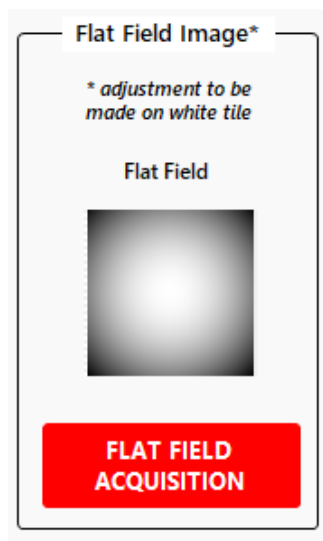
Figure 83 - White balance calibration

2.6.4. Flat Field image

The Flat Field calibration measures the light inhomogeneity and calculates a Flat Field image. This image is then used by the MAMBO software to correct this inhomogeneity in MAMBO measurements.

This calibration needs to be done on the color checker white tile.

Once the MAMBO is positioned on the white tile, you can click on **Flat Field Acquisition** to start the calibration process. The Flat Field image will be displayed and saved automatically.



Flat Field Image*

** adjustment to be made on white tile*

Flat Field

FLAT FIELD ACQUISITION

Figure 84 - Flat Field calibration

2.6.5. Offset image

The Offset & Black level calibration measures darkest pixel value and offset mapping of the camera using the parameters previously calibrated.

This calibration needs to be done with the light turned off, and the MAMBO positioned on a flat surface so that no exterior light can affect this calibration.

Once the MAMBO is positioned and the light turned off, you can click on **Camera Offset & Black Level** to start the calibration process. The Black Level value and Offset image will be displayed and saved automatically.

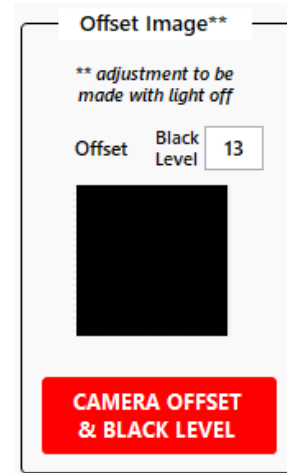


Figure 85 - Offset & Black level calibration

Once all steps have been completed, you can leave the Calibration section.

2.7. Color Calibration Window (Advanced user)

This calibration process will affect the measurements acquired with the MAMBO. This part of the software is usually greyed out and inaccessible, unless a BOSSA NOVA Vision employee provides **Advanced User** access to your MAMBO software.

If you want to conduct a new color calibration of your system, please read ahead and carefully follow the guidelines below.

In case there is any doubt about the process, please contact a BOSSA NOVA Vision employee through our website at:

<https://www.bossanovavision.com/homepage/contact-us/>

or reach out using the email address info@bossanovavision.com

While the Camera Calibration section ensures that the images taken by the MAMBO are correctly taken, the Color Calibration section enables the MAMBO to properly calculate $L^*a^*b^*$ values from the images taken by the MAMBO.

This Color Calibration must be done AFTER the Camera Calibration is conducted. A new Color Calibration MUST be done after every re-calibration of the Camera.

You can access the Color Calibration section through the **Top Menu > Calibration > Open Color Calibration tab**. This can only be accessed as an **Advanced user** in **Live Mode**.

This section consists of two Color calibration lists on the left side (Incomplete and complete calibrations), while the right side provides details on the elements of the selected calibration (**Figure 86 - Color Calibration section**).

COLOR CALIBRATIONS

July 2025

Use selected calibration

INCOMPLETE CALIBRATIONS

Add new calibration

Selected Calibration

COLORS

- Low Sat Red
- Low Sat Yellow
- Low Sat Green
- Low Sat Cyan
- Low Sat Blue
- Low Sat Magenta
- 10% red tint
- 10% green tint
- 10% blue tint
- 90% Red Tone
- 90% Green Tone
- 90% Blue Tone
- Lightest Skin
- Lighter Skin
- Moderate Skin
- Medium Skin
- Deep Skin
- 95% gray
- 5% gray
- 10% gray
- 30% gray
- 50% gray
- 70% gray
- 90% gray
- White
- 20% gray
- 40% gray
- 60% gray
- 80% gray
- Black
- Primary Cyan
- Primary Magenta

L*	a*	b*
61.35	34.81	18.38
Red	Green	Blue
154.26	89.38	72.58
Exposure		
19510		

Replace

Generate Calibration files

Figure 86 - Color Calibration section

By default, only one default color calibration is present. This color calibration is done on the DataColor Color Checker provided with the MAMBO.

The color calibration can be done multiple times with the same Color Checker over time, or with different color checkers as long as:

- measurements can be done with the MAMBO on all the tiles of the color checker
- all the calibrated L*a*b* values of the tiles are provided by the manufacturer

2.7.1. Add a new Color Calibration

To add a new color calibration, you can click on the **Add new calibration** control under the **Incomplete calibrations** List (Figure 87 - Add new calibration).



Figure 87 - Add new calibration

First, the MAMBO software will require you to upload a text file containing the calibrated $L^*a^*b^*$ values of the tiles provided by the manufacturer. The file must be formatted as follows:

Tile name # 1	tab	L* value	tab	a* value	tab	b* value
Tile name # 2	tab	L* value	tab	a* value	tab	b* value

On the right is a sample of what the text file should look like (Figure 88 - Example of $L^*a^*b^*$ calibration file).

The example corresponds to the $L^*a^*b^*$ values of the DataColor Color Checker provided with the MAMBO.

This text file should be available in the MAMBO software main folder.

You will need to acquire or build your own file if you want to use a different color calibration tool.

Low Sat Red	61.35	34.81	18.38
Low Sat Yellow	75.5	5.84	50.42
Low Sat Green	66.82	-25.06	23.47
Low Sat Cyan	60.53	-22.62	-20.4
Low Sat Blue	59.66	-2.03	-28.46
Low Sat Magenta	59.15	30.83	-5.72
10% red tint	82.68	5.03	3.02
10% green tint	82.25	-2.42	3.78
10% blue tint	82.29	2.2	-2.04
90% Red Tone	24.89	4.43	0.78
90% Green Tone	25.16	-3.88	2.13
90% Blue Tone	26.13	2.61	-5.03
Lightest Skin	85.42	9.41	14.49
Lighter Skin	74.28	9.05	27.21
Moderate Skin	64.57	12.39	37.24
Medium Skin	44.49	17.23	26.24
Deep Skin	25.29	7.95	8.87
95% gray	22.67	2.11	-1.1
5% gray 92.72	1.89	2.76	
10% gray	88.85	1.59	2.27
30% gray	73.42	0.99	1.89
50% gray	57.15	0.57	1.19
70% gray	41.57	0.24	1.45

Figure 88 - Example of $L^*a^*b^*$ calibration file

Once the text file has been selected, the software will ask you to give a name to this new color calibration (Figure 89 - New Color Calibration name).

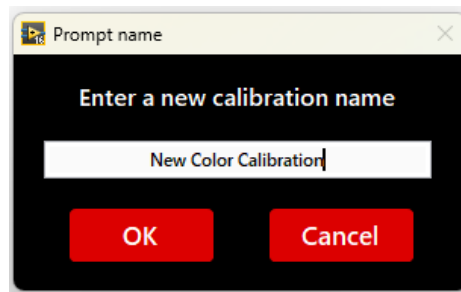


Figure 89 - New Color Calibration name

Click on **OK** to finalize the creation of this Color Calibration. This new calibration will be added to the **Incomplete Calibrations** List. To complete this Color Calibration, you need to acquire images of all the Color Checker elements and generate the calibration files.

2.7.2. Add / Replace elements to the Color Calibration

If you click on one of the incomplete or complete Color Calibration, the Selected Calibration section will display all the colors the calibration contains (**Figure 90 - Select Calibration section – Incomplete Calibration**).

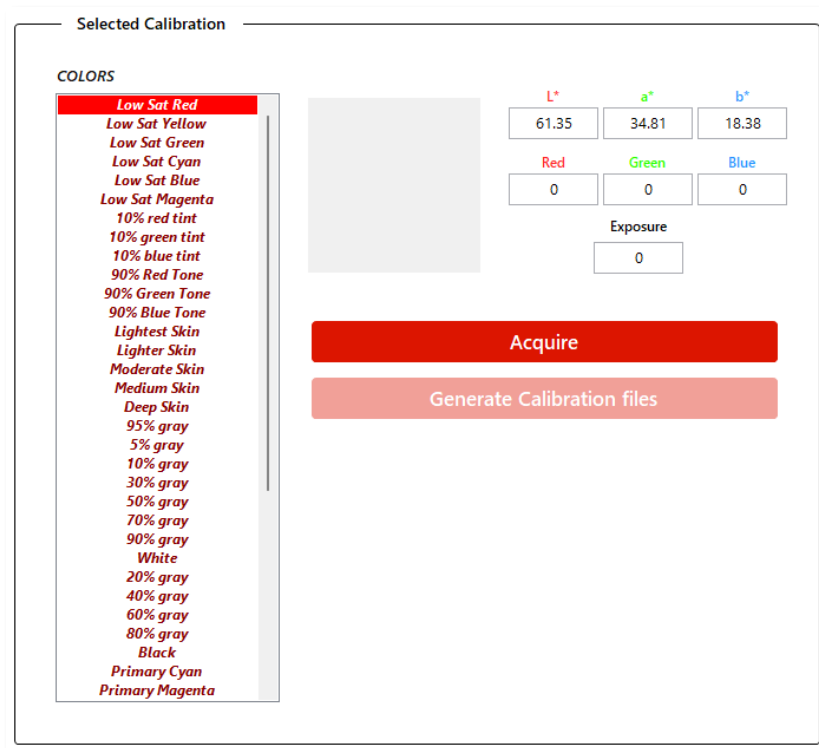


Figure 90 - Select Calibration section – Incomplete Calibration

The list of Colors is automatically generated using the text file you provided during the Color Calibration creation process.

Any Color that has no measurement associated with will be displayed in Red/Italic font, its preview section will only provide L*a*b* values and the measurement control will display **Acquire** (Figure 90 - Select Calibration section – Incomplete Calibration).

Any Color that already has a measurement associated with will be displayed in Black/Plain font, its preview section will provide an image, L*a*b*, RGB and exposure values. The measurement control will display **Replace** (Figure 91 - Select Calibration section – Complete Calibration).

The screenshot shows a window titled "Selected Calibration". On the left is a list of colors under the heading "COLORS". "Low Sat Red" is highlighted in red. To the right of the list is a color preview of a reddish-brown square. Further right are input fields for L*, a*, and b* values, each with a corresponding color label (Red, Green, Blue) above it. Below these are fields for Red, Green, and Blue values. At the bottom right is an "Exposure" field. At the bottom center are two red buttons: "Replace" and "Generate Calibration files".

L*	a*	b*
61.35	34.81	18.38

Red	Green	Blue
154.26	89.38	72.58

Exposure: 19510

Figure 91 - Select Calibration section – Complete Calibration

To add or replace a color in your Color Calibration, place your MAMBO on the tile corresponding to the color you have selected, and click on **Acquire** or **Replace**.

2.7.3. Generate the Calibration files

Once you've completed all measurements, you need to generate the Calibration files. The software will do so automatically once you click on the associated control (Figure 92 - Generate Calibration files control).



Figure 92 - Generate Calibration files control

If you **Replace** a Color in an existing Color Calibration with previously generated calibration files, you will need to generate new calibration files.

2.7.4. Select the Color Calibration to use with MAMBO

Once you have generated the files for your Color Calibration, it can be selected from the **Color Calibrations** list (Figure 93 - Color Calibrations list), instead of the **Incomplete Calibrations** list.

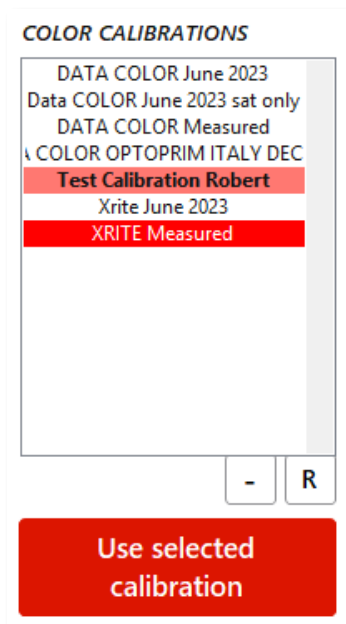


Figure 93 - Color Calibrations list

The color calibration currently used by the MAMBO for $L^*a^*b^*$ values calculations is highlighted with a light red background, and a Black/Bold font.

To change the Color Calibration, simply select another one in the list, and click on the **Use selected calibration** control.

2.7.5. Delete / Rename Color Calibrations

Rename a color calibration

You can rename a color calibration. To do so, select the calibration you want to rename (complete or incomplete) and click on the R control (R) under the corresponding list. It will trigger a pop-up window (Figure 94 - Rename color calibration) where you can enter the new name.

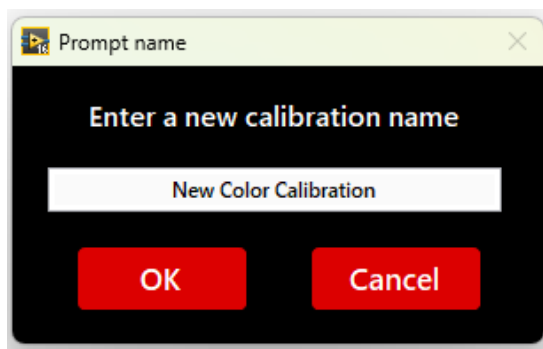


Figure 94 - Rename color calibration

Clicking on the **Cancel** control will cancel the renaming of the color calibration and close the pop-up window.

Delete a color calibration

To delete a color calibration, select the one you want to delete and click on the (–) button under the corresponding list. A window will pop up to confirm **Figure 73 - Delete a database element(Figure 95 - Delete a color calibration)**.

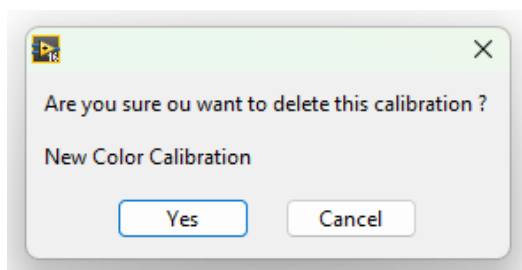


Figure 95 - Delete a color calibration

Click on **Yes** to delete the color calibration.

Be careful, deleting a color calibration is final and is not recoverable.

2.8. Illumination check calibration (Advanced User)

This calibration process will affect the illumination check-up process of the MAMBO. This part of the software is usually greyed out and inaccessible, unless a BOSSA NOVA Vision employee provides **Advanced User** access to your MAMBO software.

If you want to conduct an illumination check calibration of your system, please read ahead and carefully follow the guidelines below.

In case there is any doubt about the process, please contact a BOSSA NOVA Vision employee through our website at:

<https://www.bossanovavision.com/homepage/contact-us/>

or reach out using the email address info@bossanovavision.com

The only purpose of the Illumination check calibration is to provide references values for the illumination check-up process.

This calibration must be done AFTER the Camera Calibration is conducted. However, this calibration is not affected by the Color Calibration process.

A new illumination check calibration MUST be done after every re-calibration of the Camera.

Before starting this calibration, please make sure that the MAMBO is turned on and positioned on the MAMBO support used for the Illumination check procedure (**Figure 11 - MAMBO and its illumination check support**).

To start this calibration process, you must click on **Illumination Calibration** in the **Top menu** under the **Calibration** tab (**Figure 96 - Illumination Calibration menu**).

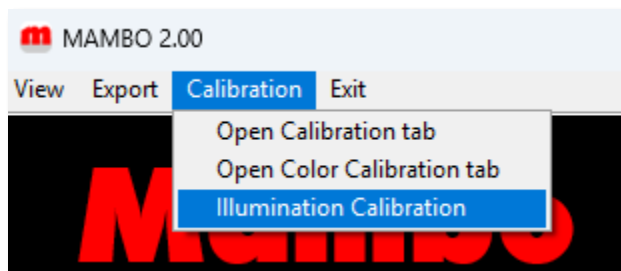


Figure 96 - Illumination Calibration menu

A window will pop up to confirm that the MAMBO has been positioned on its support (**Figure 97 - Illumination check calibration confirmation window**).

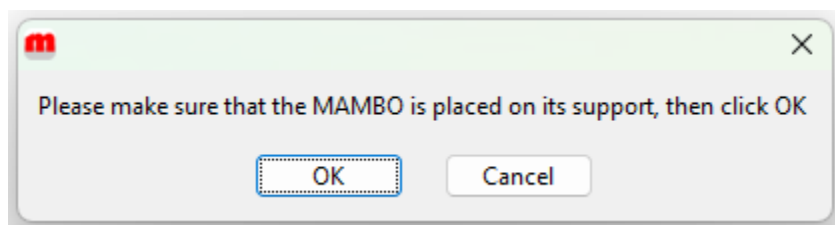


Figure 97 - Illumination check calibration confirmation window

Click on **OK** to confirm or **Cancel** to abort the process. If confirmed, new reference values will be automatically acquired and saved, and a window will pop up to confirm that the calibration has been completed (**Figure 98 - Illumination check calibration done**).

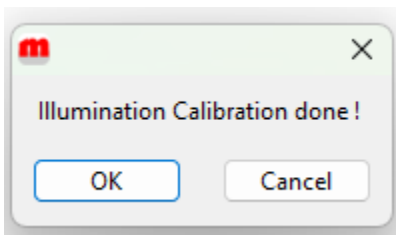


Figure 98 - Illumination check calibration done

2.9. Standard export

To export your measurements into a separate file, you can use:

- the **Standard export** (for measurement taken through the standard section)
- the **Color retention export** (for measurement taken through the Color Retention section)

For the Standard export, you can access it through the **Top Menu**, under the **Export** Section, by clicking on **Standard** (Figure 99 - Accessing the standard export window).

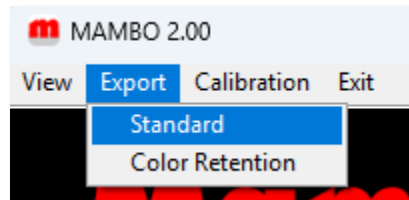


Figure 99 - Accessing the standard export window

A new window will pop up where you will be able to list all the measurements you want to export, add the relevant comparison data and export it in a .txt file (Figure 100 - Standard export window).

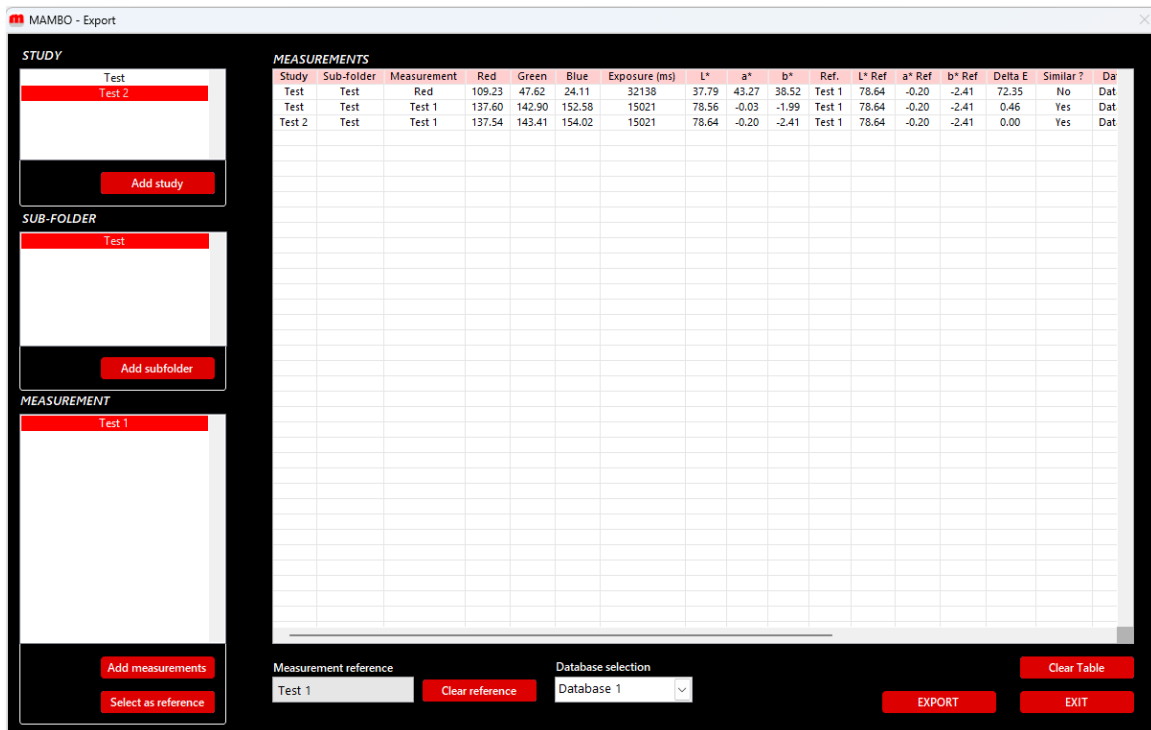


Figure 100 - Standard export window

2.9.1. Filling in your export list

To fill in your export list, you can:

- add all measurements from a study by selecting a study from the **Study list** and clicking on **Add study**
- add all measurements from a subfolder by selecting the appropriate study, selecting a subfolder from the **Sub-folder list** and clicking on **Add subfolder**
- add single measurements by selecting the appropriate study, then selecting the appropriate subfolder, selecting the measurements from the **Measurement list** and clicking on **Add measurements**

All selected measurements will be displayed on the **Measurement table**.

You can empty the **Measurement table** by clicking on the **Clear Table** control, located in the bottom right corner of the export window (Figure 101 - Clear Table control).

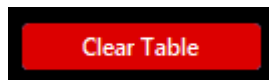


Figure 101 - Clear Table control

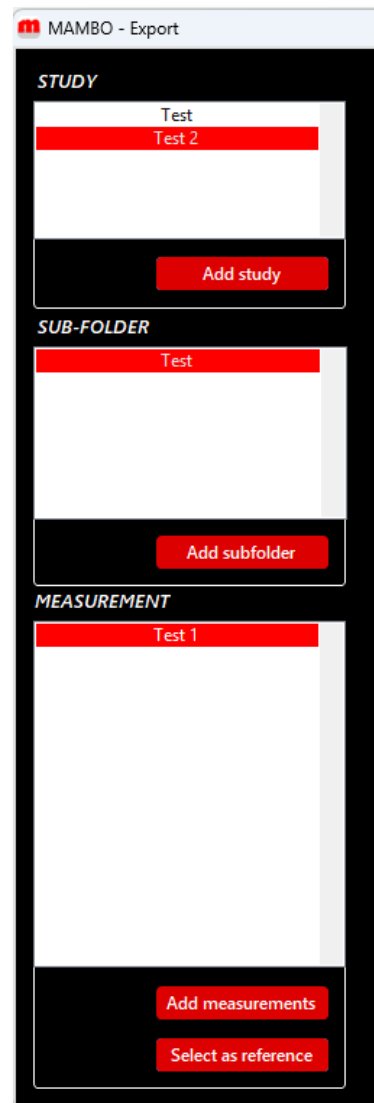


Figure 102 - Adding to the export list

By default, the data that fills up the Measurement table will contain:

- the study, subfolder and measurement names
- RGB and exposure values
- the corresponding L*a*b* values with the current Color Calibration

2.9.2. Adding comparison values

On top of the usual parameters, it is possible to add comparison values to the Measurements table. It is possible to add comparison values with a single measurement, or comparison values with a database.

Comparison with a single measurement

To select a reference for your single measurement, you first need to select a measurement using the study, subfolder and measurement lists. Once selected, click on the **Select as reference** control (Figure 103 - Select as reference control).

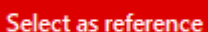


Figure 103 - Select as reference control

The name of the measurement used as a reference for the comparison will then be displayed in the **Measurement reference** indicator (Figure 104 - Measurement reference indicator). To remove the reference, click on the **Clear reference** control next to the indicator.



Figure 104 - Measurement reference indicator

If you have an active measurement reference, additional parameters will be displayed in the **Measurement table**, as shown in the image below (Figure 105 - Single measurement comparison in Table). You will see the name of the reference, the corresponding L*a*b* values, the ΔE value between each measurement and the reference, and the YES/NO information on if the ΔE value passes the threshold:

- If $\Delta E < 2.3$, the colors are considered similar
- If $\Delta E > 2.3$, the colors are not considered similar

Ref.	L* Ref	a* Ref	b* Ref	Delta E	Similar ?
test1	35.38	28.91	28.92	0.00	Yes
test1	35.38	28.91	28.92	0.74	Yes
test1	35.38	28.91	28.92	1.24	Yes
test1	35.38	28.91	28.92	1.39	Yes
test1	35.38	28.91	28.92	1.09	Yes
test1	35.38	28.91	28.92	1.45	Yes
test1	35.38	28.91	28.92	2.31	No
test1	35.38	28.91	28.92	3.39	No

Figure 105 - Single measurement comparison in Table

Comparison with database

To select a database for your single measurement, you need to select a database using the Database selection menu (Figure 106 - Database selection menu). To remove the database, select the empty option in the menu, which should be the first option available.

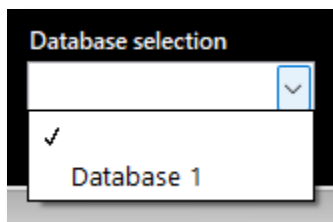


Figure 106 - Database selection menu

Once you select a database, additional parameters will be displayed in the **Measurement table**, as shown in the image below (Figure 107 - Database comparison in Table). You will see the name of the database, the name of the closest color in the database (measured by smallest ΔE), the corresponding $L^*a^*b^*$ values, the ΔE value between the measurement and the closest color, and the YES/NO information on if the ΔE value passes the threshold:

- If $\Delta E < 2.3$, the colors are considered similar
- If $\Delta E > 2.3$, the colors are not considered similar

Database	Closest element	L^* - DB	a^* - DB	b^* - DB	Delta E - DB	Similar ?
CC oct 2022	neutral 6.5	66.96	-0.90	-0.59	13.56	No
CC oct 2022	light skin	65.08	19.56	17.81	24.05	No
CC oct 2022	light skin	65.08	19.56	17.81	21.43	No
CC oct 2022	light skin	65.08	19.56	17.81	13.60	No
CC oct 2022	neutral 3.5	35.59	-0.43	-1.14	29.57	No
CC oct 2022	neutral 3.5	35.59	-0.43	-1.14	29.68	No
CC oct 2022	neutral 3.5	35.59	-0.43	-1.14	27.70	No
CC oct 2022	neutral 3.5	35.59	-0.43	-1.14	25.88	No
CC oct 2022	neutral 3.5	35.59	-0.43	-1.14	25.36	No
CC oct 2022	neutral 3.5	35.59	-0.43	-1.14	24.82	No
CC oct 2022	neutral 3.5	35.59	-0.43	-1.14	22.07	No

Figure 107 - Database comparison in Table

2.9.3. Exporting the data

Once you have properly added all the measurement and parameters you want to export, you can simply click on the **EXPORT**,



Figure 108 - EXPORT control

A window will pop up to ask where the file should be saved, and what name to give it. You can then click on OK, and a text file (extension .txt) with your data and the name you gave it will be available at the selected location (**Figure 109 - Export location selection**).

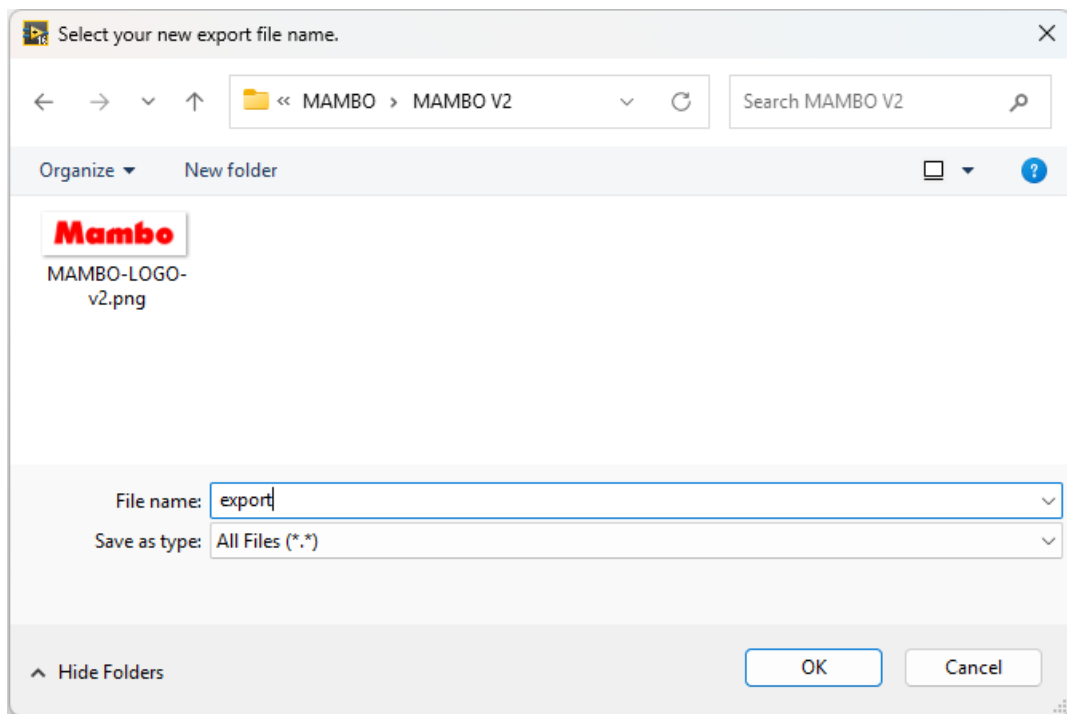


Figure 109 - Export location selection

2.9.4. Exiting the standard export

Once the exporting process is over, you can exit the Standard export window by clicking on the **EXPORT** control (**Figure 110 - EXIT control**) in the lower right corner of the window.



Figure 110 - EXIT control

2.10. Color Retention Export

For the Color Retention export, you can access it through the **Top Menu**, under the **Export** Section, by clicking on **Color Retention** (Figure 111 - Accessing the color retention export window).

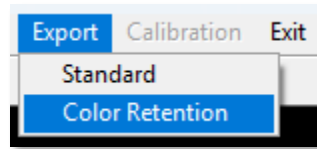


Figure 111 - Accessing the color retention export window

Similar to the standard export, a new window will open and asks for the location and name of the file to export.

This export process will write the data from the current selected study into the export file, which will contain the following parameters for all measurements in the study:

- Event name
- Event #
- Group name
- Swatch name
- Orientation (Front or Back)
- Position (Root, Middle or Tip)
- L*a*b* values

3. Technical Background

The MAMBO uses a diffuse white LED illumination to illuminate the hair swatch and a camera to acquire an image of the hair swatch.

The diffuse illumination allows to minimize reflection on hair fibers and only measure the real hair color.

Thanks to our proprietary color calibration using the color checker, MAMBO can deliver reliable $L^*a^*b^*$ measurements of the hair swatch color.

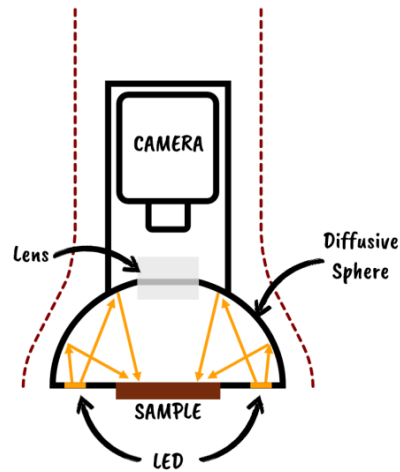


Figure 112 - MAMBO schematic

Using MAMBO, it is possible to create a color database and to compare measurement to the DATABASE elements using the Lab distance (ΔE) formula.

$$\Delta E = \sqrt{(L_{meas.} - L_{elem.})^2 + (a_{meas.} - a_{elem.})^2 + (b_{meas.} - b_{elem.})^2}$$

It is possible to calculate ΔE between the color measurement and each element of the database in order to identify the closes color database element. If $\Delta E < 2.3$, the color difference is not noticeable.

MAMBO uses that formula to analyze databases and identify color elements that are very similar.

4. Technical Specifications

Measurement Size	12.56 mm x 12.56 mm
Image size	1,500 x 1,500 pixels
Camera	USB 3.00 12 bits color
Power Supply	12 Vdc
Software	MAMBO 2.00
Operating system	Windows 10/11
Camera computer connection	USB 3.00
DATA Output	8 bits monochrome image in .png Text files – Lab values
Calibration	Factory calibrated
Power requirement	110/220 VAC 50/60 Hz