

Samba Hair System

*Objective measurement of parameters
involved in the visual appearance of hair*

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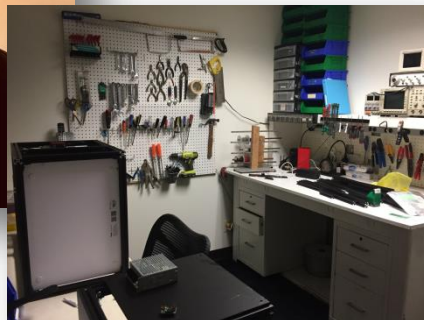
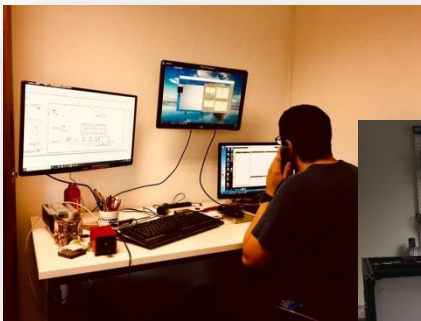
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Overview of Bossa Nova Vision

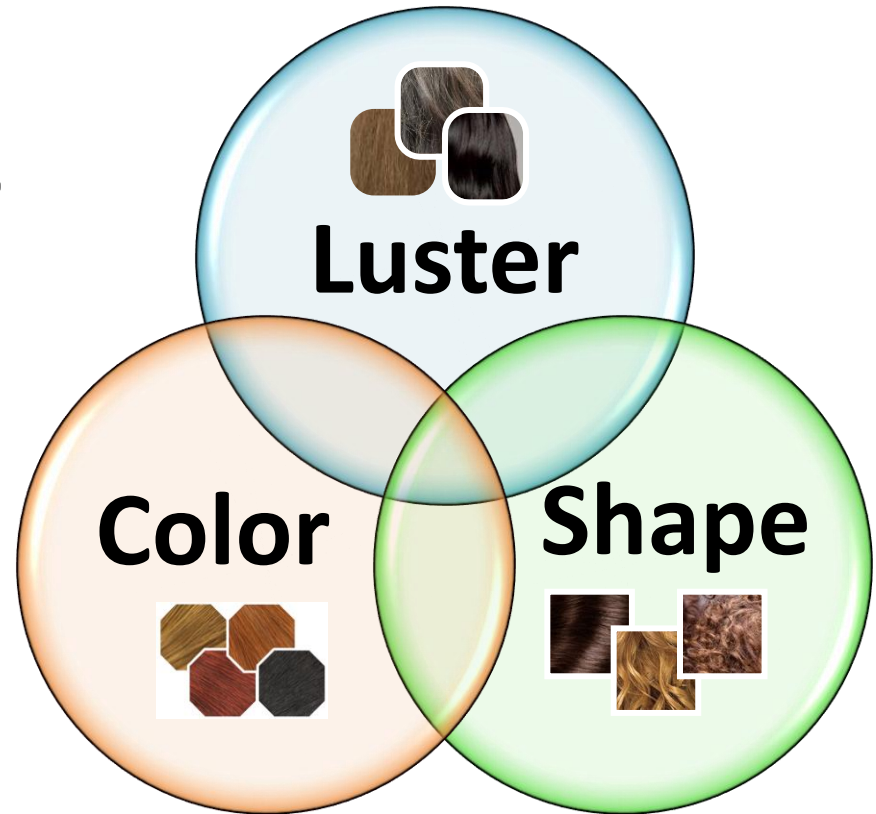
BOSSA NOVA Vision, formerly BOSSA NOVA Technologies, is a LLC (Limited Liability Company) **founded in 2018**, located in **Los Angeles, USA**

Small business of 4 people specialized in optics, electronics, imaging and software development (3 PhDs, 1 Engineer)



What is Luster ?

Visual appearance of hair
is a combination of...



Problematic

Measuring the parameters and correctly quantifying Luster

What is Luster ?

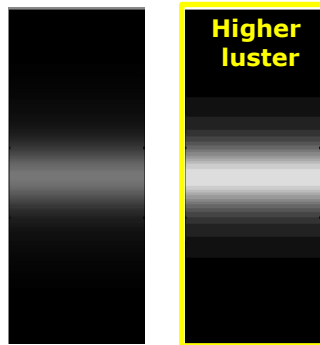
Luster **qualifies the visual appearance** of the object

Luster is strongly linked to the idea of quality and beauty of an object

Scientists have tried to compute a parameter that would **quantify the visual luster sensation***

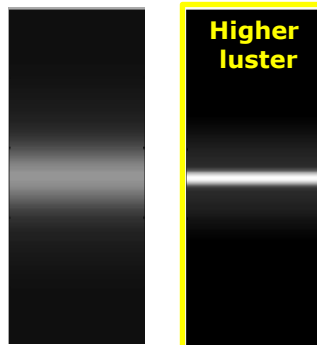
Luster sensation is considered to depend on 3 main parameters:

The **amount** of reflected light



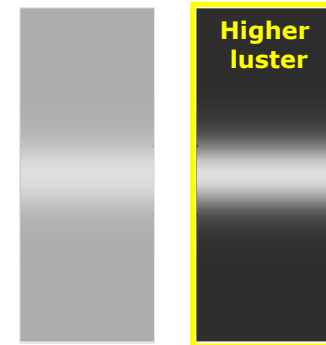
The more reflected light there is,
the higher the luster is

The **sharpness** of the reflection



The sharper the reflection is,
the higher the luster is

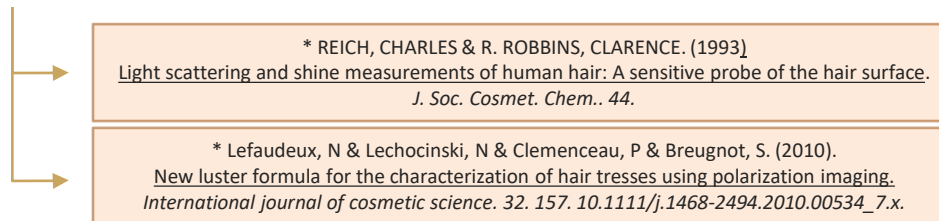
The **background** on which the reflection is observed



The darker the background is,
the higher the luster is

What is Luster ?

Several Luster formulae have been developed and published* by scientists using goniometers and other instruments to tentatively quantify human perception of Luster



The parameters used in the formulae are :

- S the total amount of the specular light
⇒ **Reflected Light**
- D the total amount of the diffused light
⇒ **Background Light**
- $\theta_{1/2}$ the width of the specular light distribution
⇒ **Light band Sharpness**

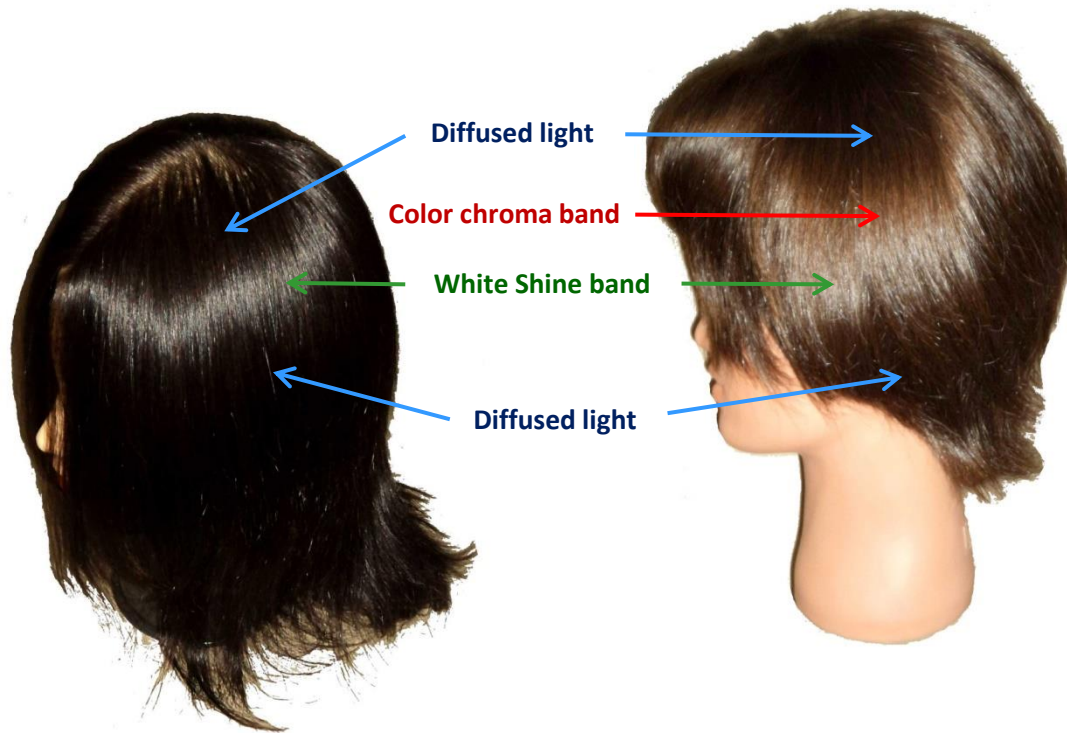
Examples of formulae :

$$L_{Reich-Robbins} = \frac{S}{D \times \theta_{1/2}}$$

$$L_{TRI} = \frac{S}{S+D} \cdot \frac{\theta_{ref}}{\theta_{1/2}}$$

$$L_{BNT} = \frac{S_{in}}{(D + S_{out}) \times W_{visual}}$$

Example on mannequin heads

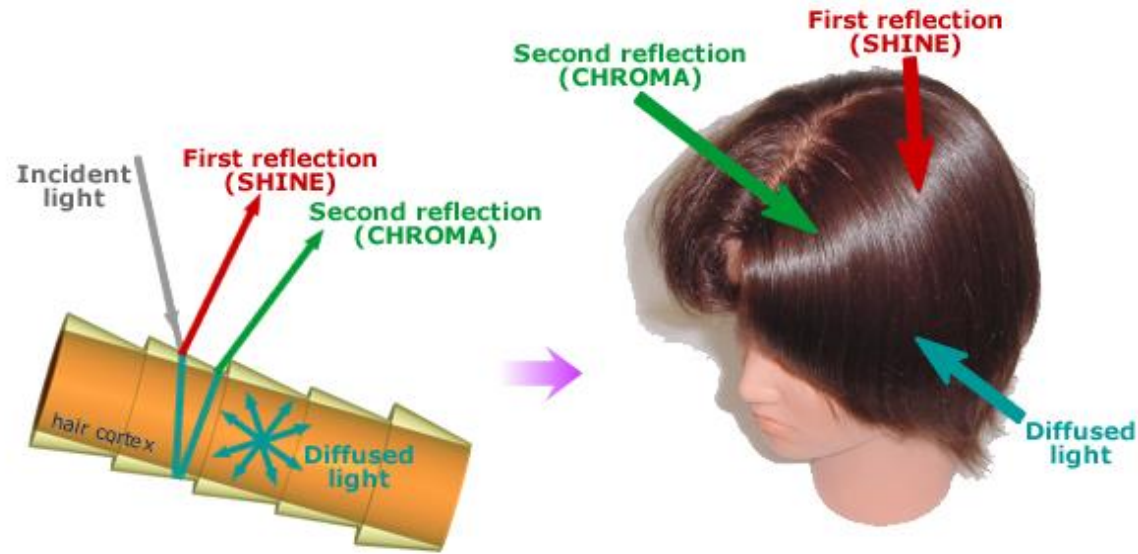


Incident light splits into **shine**, **chroma** (specular) and **diffused**

Diffused and **chroma** carry color information

Luster is highly related to the background color (**diffused**), surface quality and the hair style / alignment of the fibers

Interaction of light with hair fibers

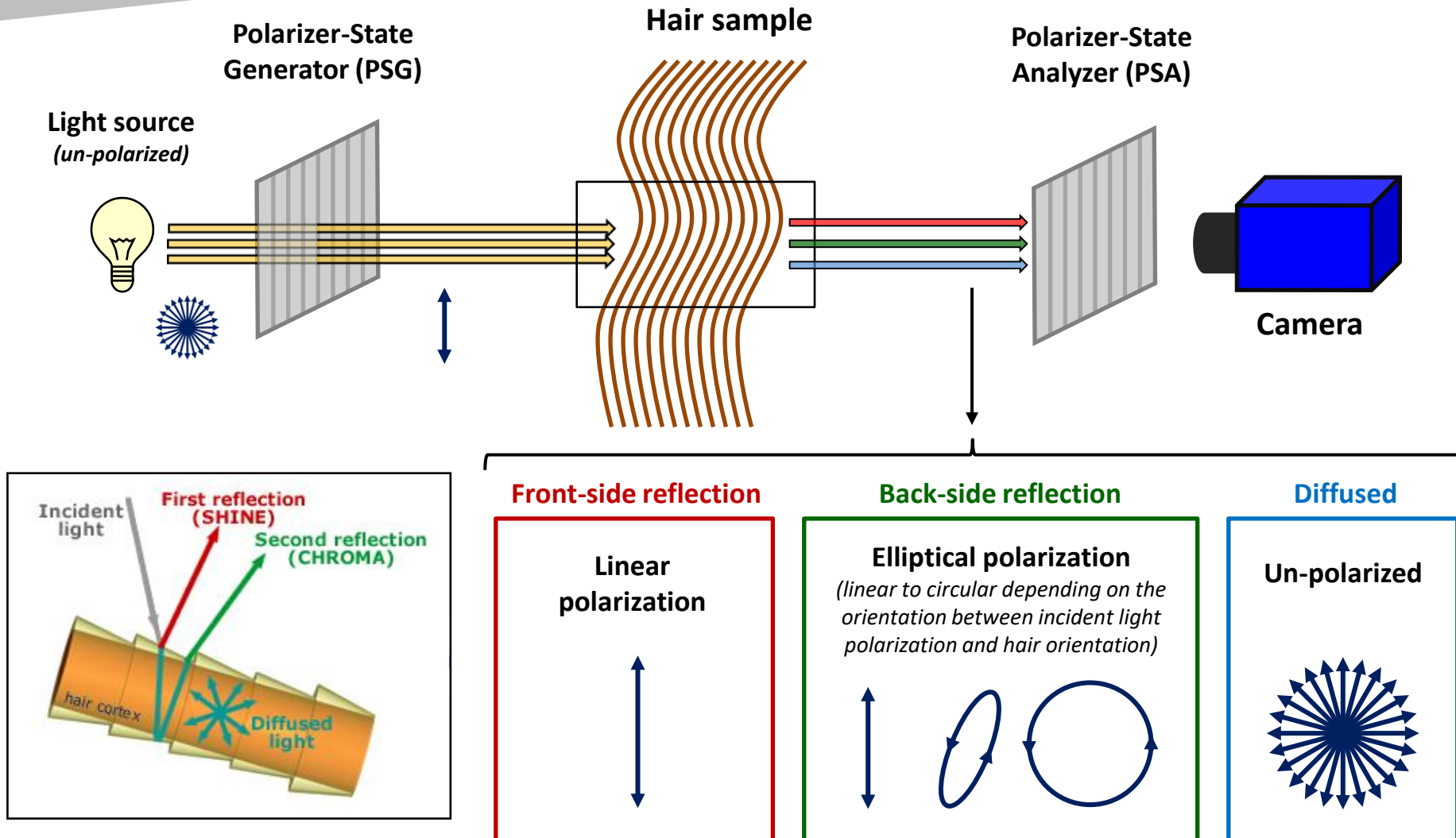


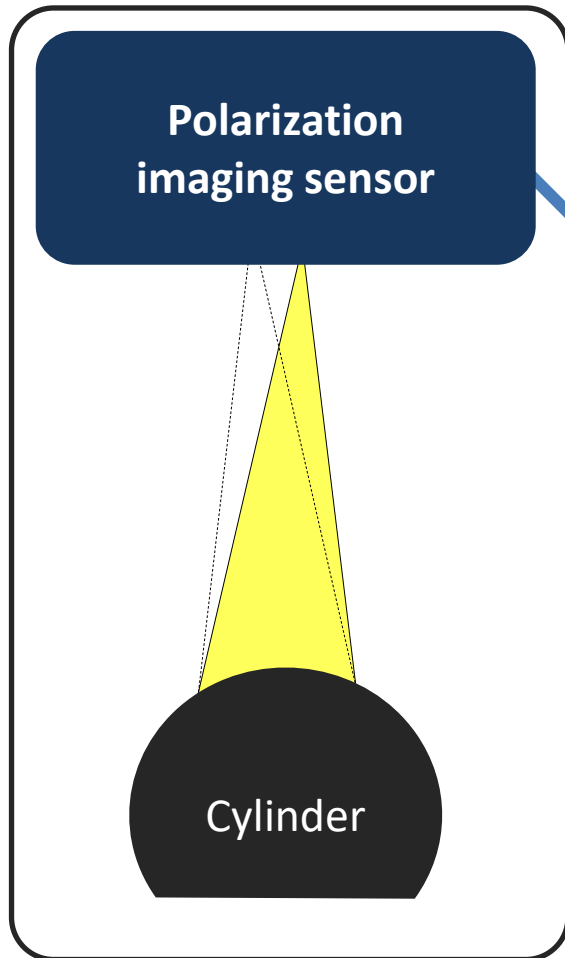
Incident light splits into
Specular and Diffused

Front-side / Back-side
Shine / Chroma



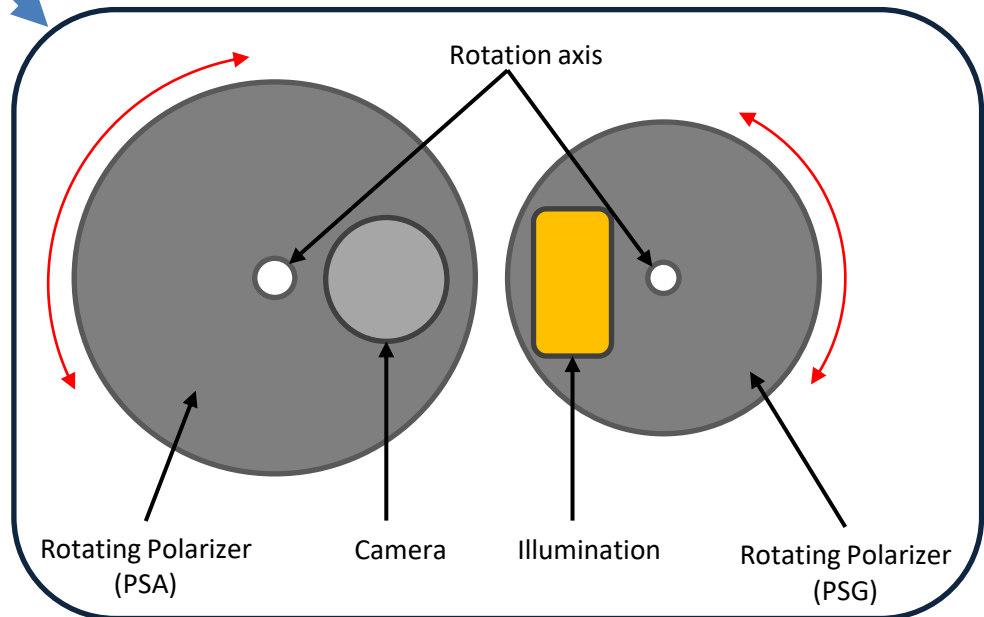
Each light component has
its own polarization
characteristics





The setup of the SAMBA Hair is based on three elements :

1. An illumination with a rotating PSG
2. A cylinder where the hair samples are positioned
3. A camera with a rotating PSA



The flexibility in the PSG and PSA angles allow the SAMBA Hair to take images with any kind of polarization configuration, as long as the polarization is linear.

The correct set of polarization angles allows the resolution of images for Shine, Chroma and Diffused

SAMBA Hair		4 PSG / 4 PSA	
	PSG		PSA
	0°		0°
	0°		90°
	30°		120°
	60°		150°

$$= I_1$$

$$= I_2$$

$$= I_3$$

$$= I_4$$

Equations for the resolution of:

- Shine (S)
- Chroma (C)
- Diffused (D)

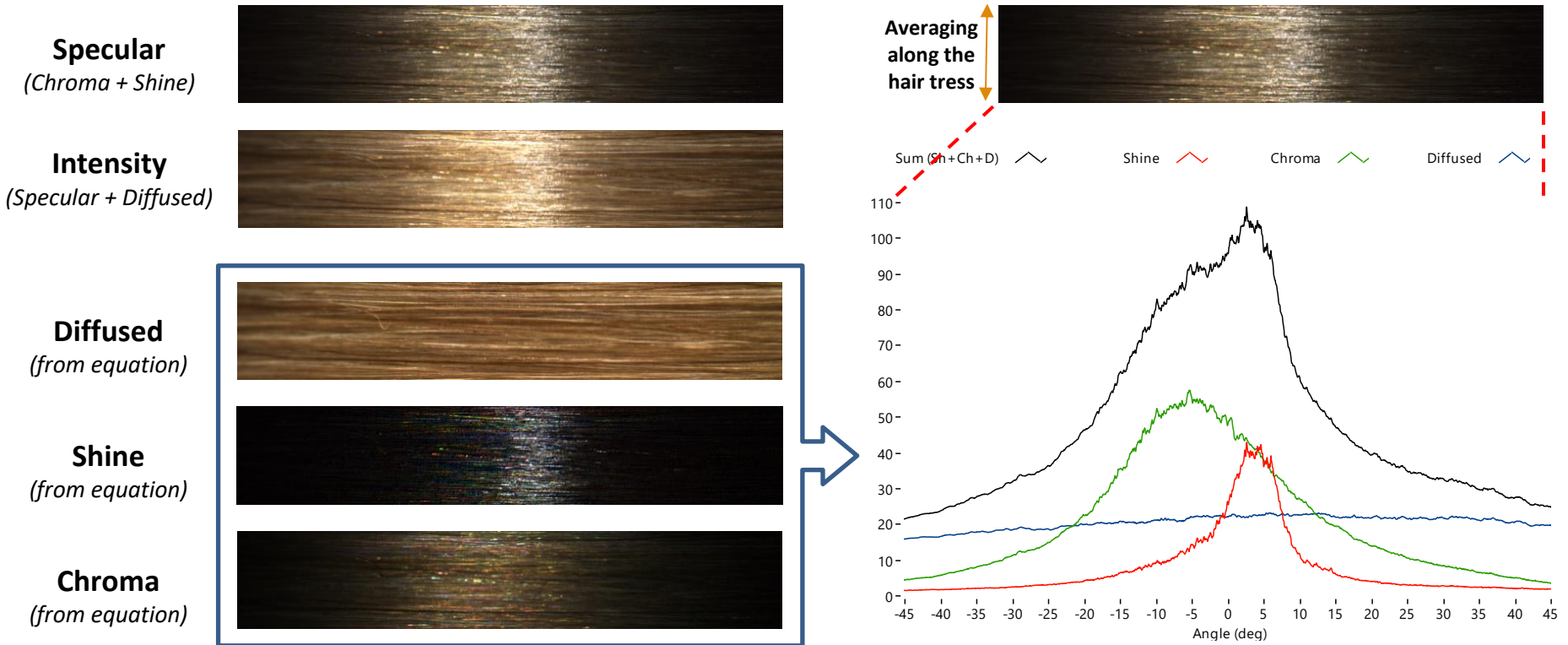
$$S = I_1 + I_2 - (C + D)$$

$$C = \frac{8}{3} \sqrt{I_2^2 + I_3^2 + I_4^2 - (I_2 I_3 + I_2 I_4 + I_3 I_4)}$$

$$D = \frac{2}{3} (I_2 + I_3 + I_4) - \frac{C}{2}$$

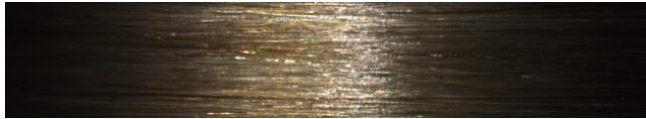
$$\vartheta_f = \frac{1}{4} \tan^{-1} \left(\frac{3(I_3 - I_4)}{\sqrt{3}(2I_2 - I_3 - I_4)} \right) + k \frac{\pi}{4}$$

Below is an example of the images obtained by the SAMBA Hair system on a standard blond swatch, and the corresponding angular profiles



Profile extraction for luster calculation

Specular image

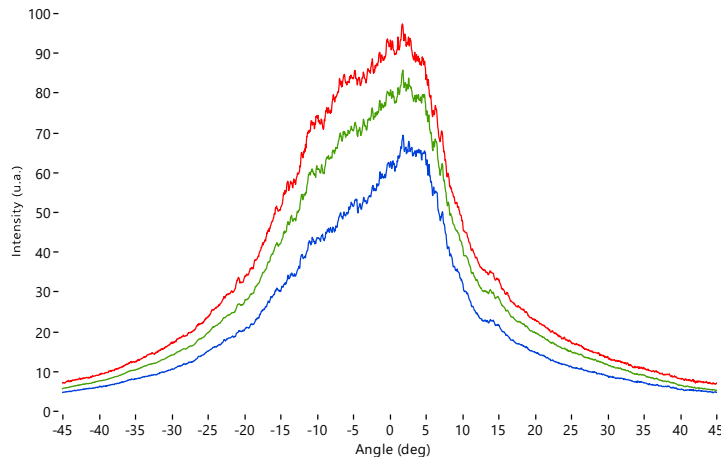


Averaging
along the
hair tress

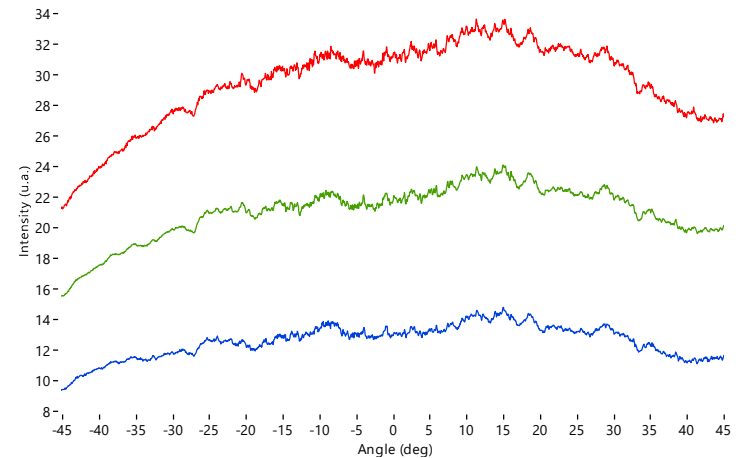
Diffused image



Specular angular distributions



Diffused angular distributions



**Characterization of the profiles
with numerical parameters such
as maxima, integrals and width**



LUSTER

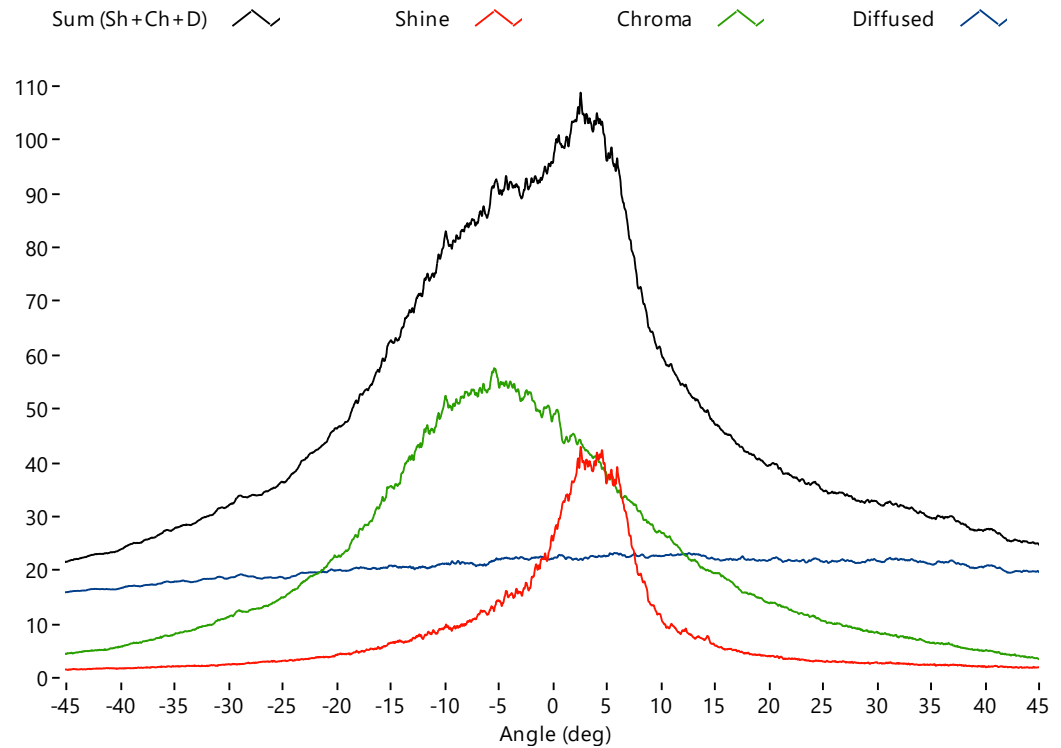
	Theta0	W_visual	Max	Integral
Specular	15.29	20.87	86.68	2598.05
Diffused	-	-	23.04	1856.22

Examples on different hair colors (blond)

Images



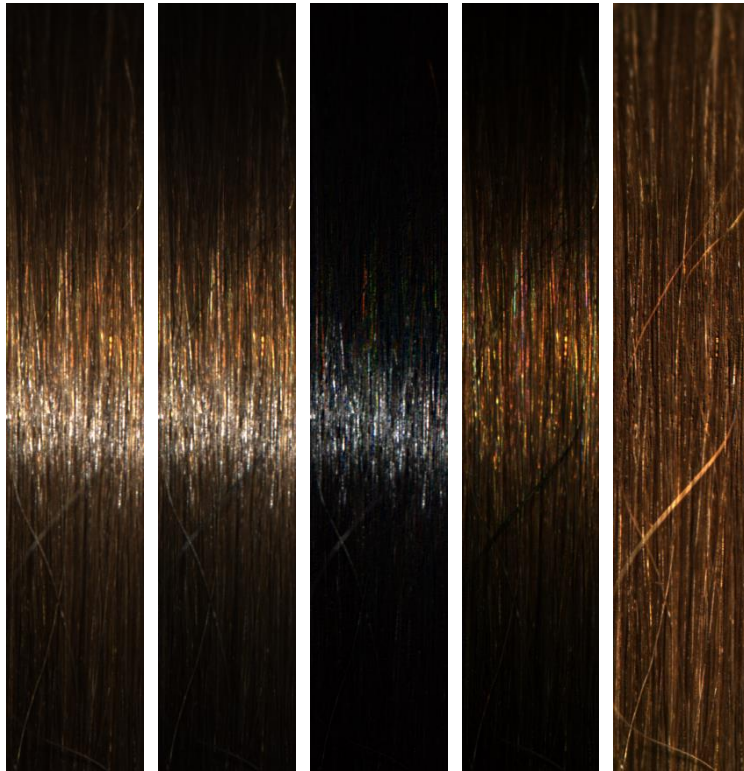
Profiles



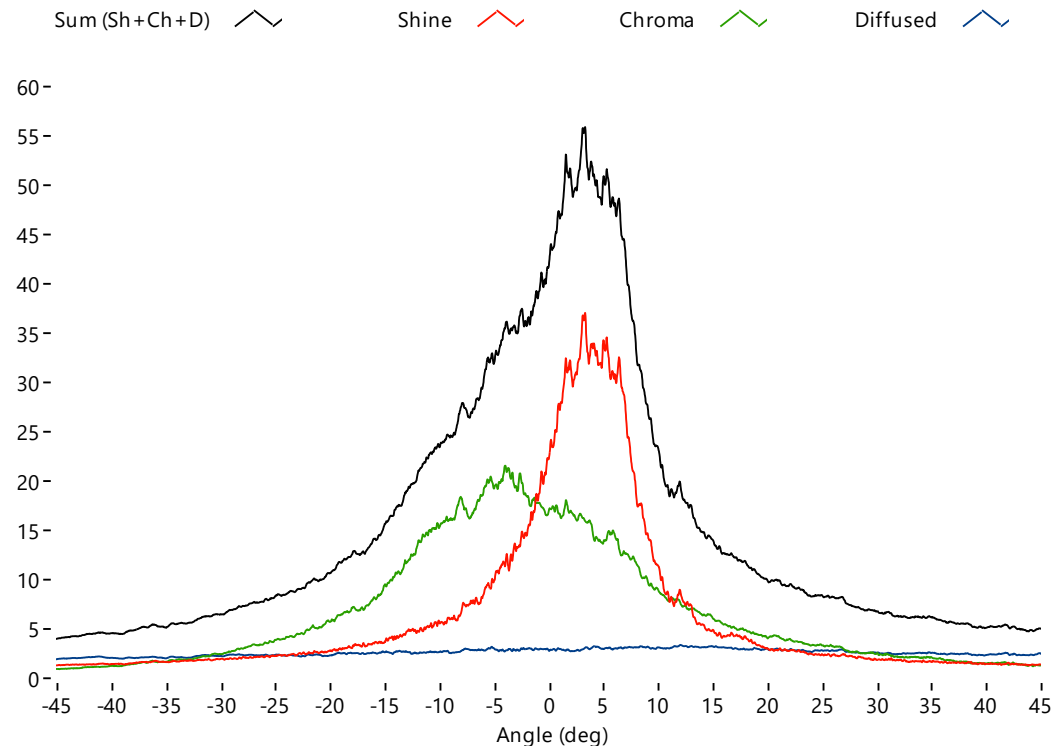
	BNT	Reich-Robbins
Luster Value	4.35	9.16

Examples on different hair colors (brown)

Images



Profiles



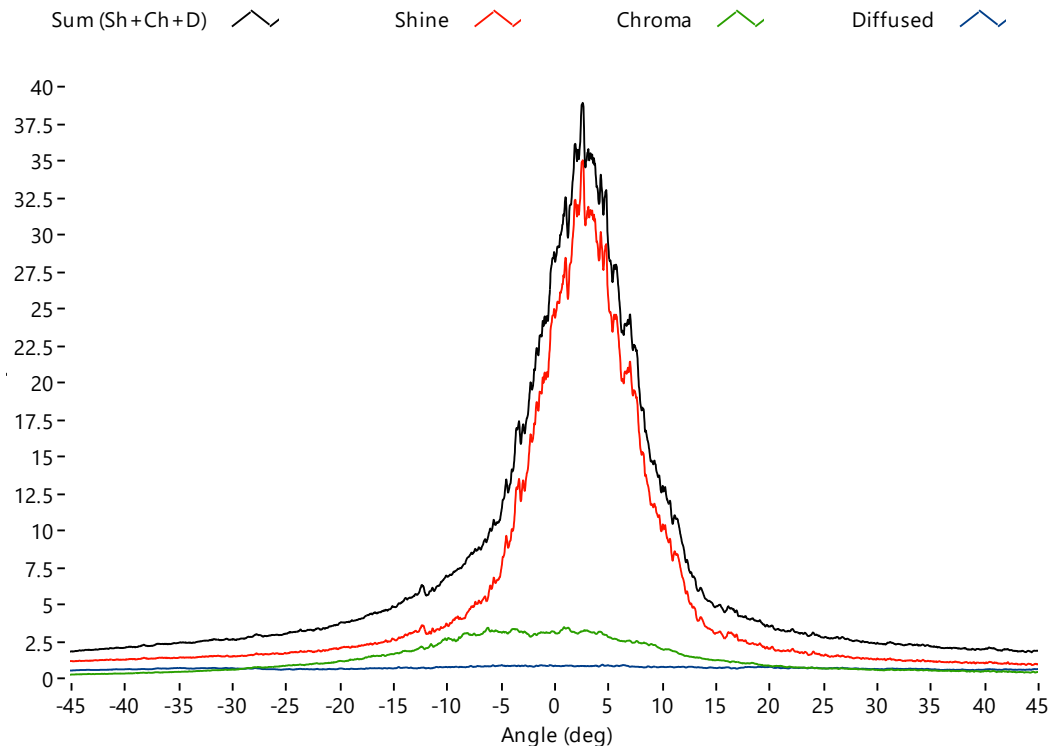
	BNT	Reich-Robbins
Luster Value	16.46	46.35

Examples on different hair colors (black)

Images



Profiles



	BNT	Reich-Robbins
Luster Value	35.18	152.27

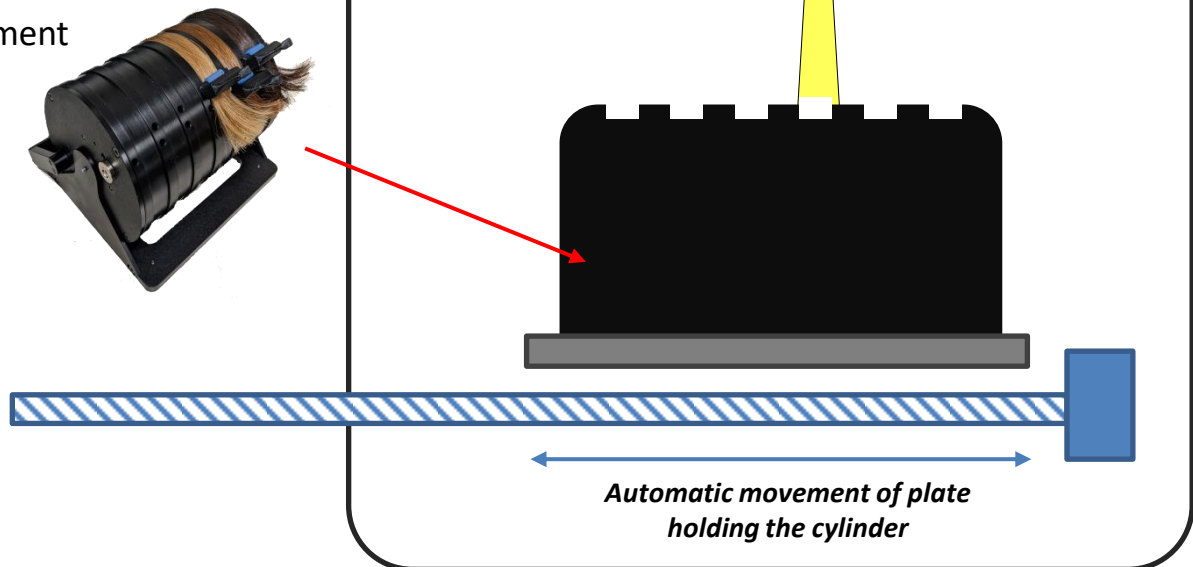
Automation is important - from the user side - in order to minimize the need for user interaction with the machine

It can save time when planning campaigns that require a significant amount of data

Measurement automation aspect # 1

The cylinder can hold up to 6 swatches at the same time. During the measurement process, it is put on a translation.

This allows the system to acquire data for all the swatches (up to 6) in a single acquisition

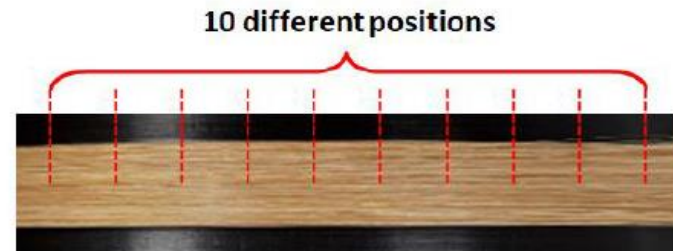
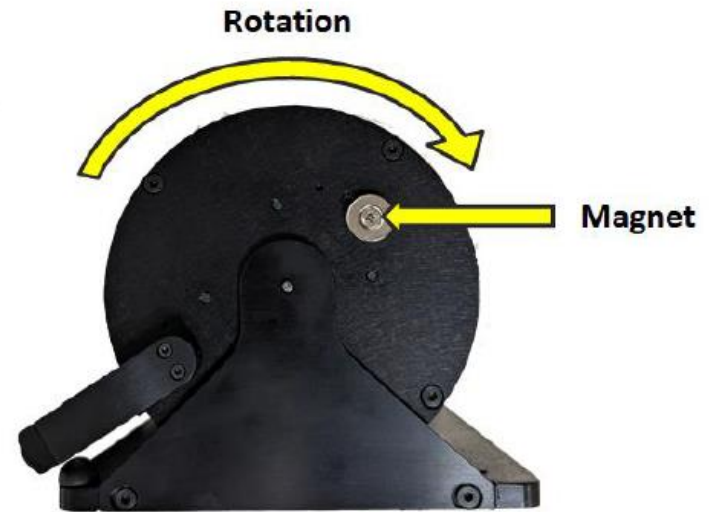


Measurement automation aspect #2

The cylinder can rotate on its axis, and is connected to a motor inside the SAMBA Hair system using a magnet.

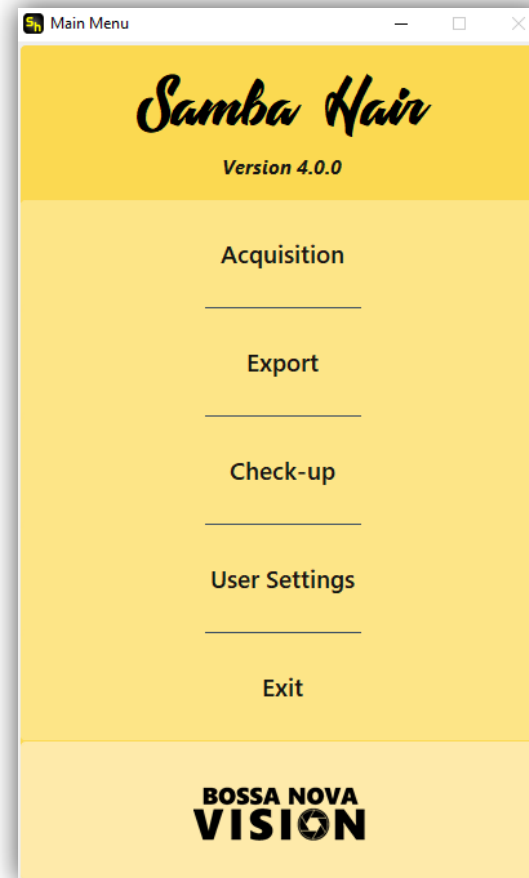
This allows the system to acquire images centered on up to 10 different positions for a single swatch, on each swatch put on the cylinder.

With the cylinder translation and rotation, this means that **a single acquisition can results in 60 measurements** (up to 10 measurements per swatch on up to 6 swatches)



From this main menu, you have access to :

- **Acquisition** : for acquiring new measurements
- **Export** : for exporting numerical data, graphs and images
- **Check-up** : to launch a check-up process
- **User settings** : to configure user accounts
- **Exit**



Grooves
selection

Positions
selection

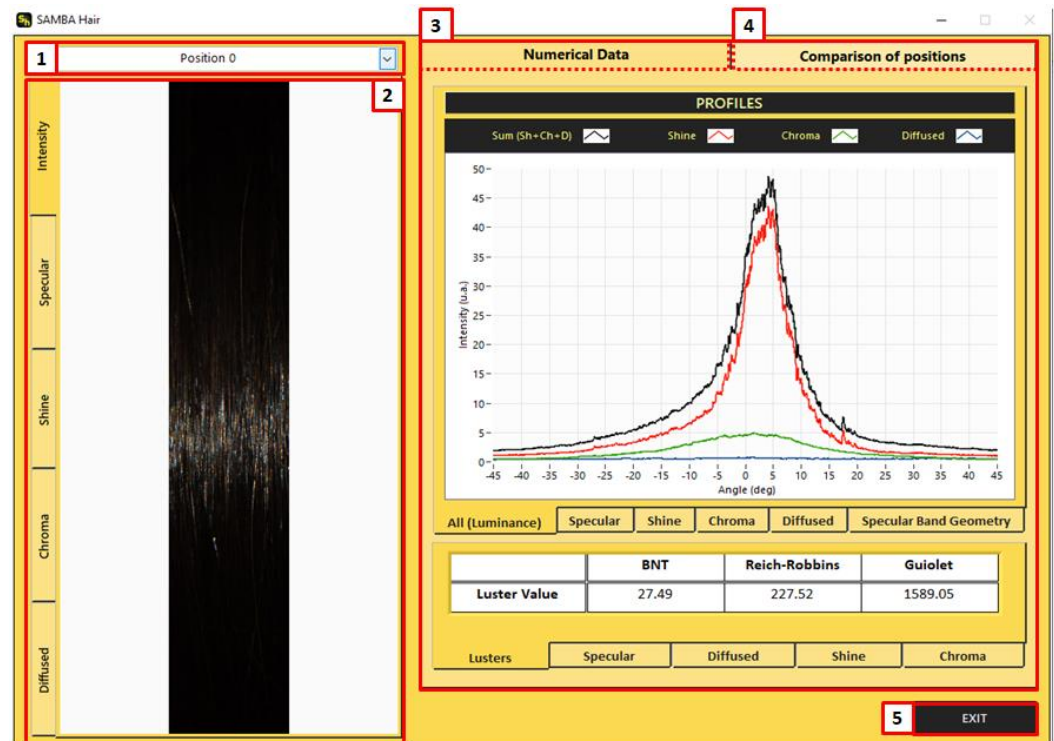
Display for current
acquisition

Data
Management

The screenshot shows the 'Acquisition' window of the 'Samba Hair' software. The interface is divided into several sections:

- Top Bar:** Contains the 'Samba Hair' logo and the title 'CAMERA ACQUISITION'.
- Left Panel:** A large empty area for the current acquisition display.
- Right Panel (Acquisition Controls):**
 - SAMPLES:** A vertical list of checkboxes for selecting measurement samples. A red arrow points to this section from the 'Grooves selection' label.
 - Measurement Name:** A list of input fields for naming measurements.
 - Cylinder going in:** A vertical arrow indicating the direction of the cylinder.
 - CLEAR ALL:** A button to reset the acquisition settings.
 - POSITIONS:** A horizontal bar with a scale from 0 to 9 and a red arrow pointing to it from the 'Positions selection' label. Below the bar are labels for 'First position', 'Center position', and an 'All' checkbox.
 - CONNECT and CAPTURE:** Two large buttons at the bottom of the right panel.
- MEASUREMENTS Section (Bottom):**
 - Study:** A dropdown menu with options like 'December2022', 'encrypted_archived', 'November 2022', 'Test_Overlap_Visibility', 'TestExe', 'testrename', and 'TestSQL2'. A red arrow points to this section from the 'Data Management' label.
 - Sub-study:** A dropdown menu with options 'Dec03' and 'Dec05'.
 - Measurement:** An empty dropdown menu.
 - EXPORT:** A button below the Study dropdown.

1. **Positions Selector:** you can select which position (from 0 to 9) is displayed
2. **Image Display Tab :** you can select which image to display (Intensity, Specular, Shine, Chroma or Diffused) using the tab on the left
3. **Numerical Data Tab :** you can visualize all the numerical parameters (profiles and profiles parameters) of the measurement you loaded, at the position you selected
4. **Comparison of positions:** you can list and have a simple comparison of numerical data from all the positions (up to 10 positions) you used for the acquisition, with Average and Standard deviation values calculated in the tables
5. **Exit :** you can exit to go back to the Acquisition window



Study
August
BNV
December2022
encrypted_archive
November 2022
Test_Overlap_Visib
TestExe
testrename
Test5BH2

Sub-study
Double Cable
pourquoi

Measurement
black
blond
brown
shblack
shwhite
whiteshine

for EXPORT

Add STUDY
Add Sub-STUDY
Add MEASUREMENT

☐ Include images
☐ Include profiles

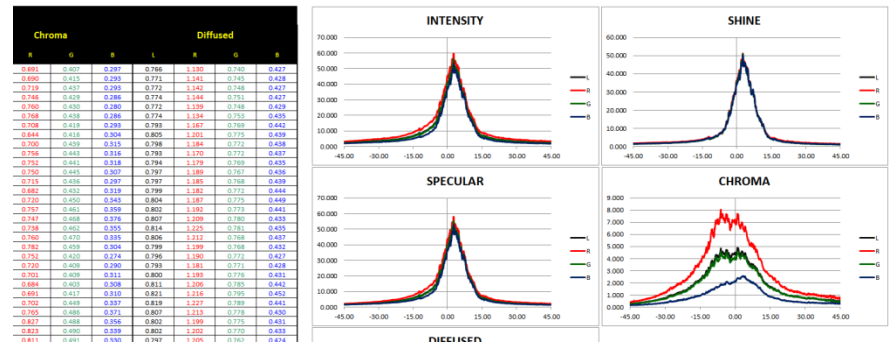
CLEAR EXPORT LIST

Current Measurements
Archived Measurements

Save as ...
.xls (Excel)

EXPORT
EXIT

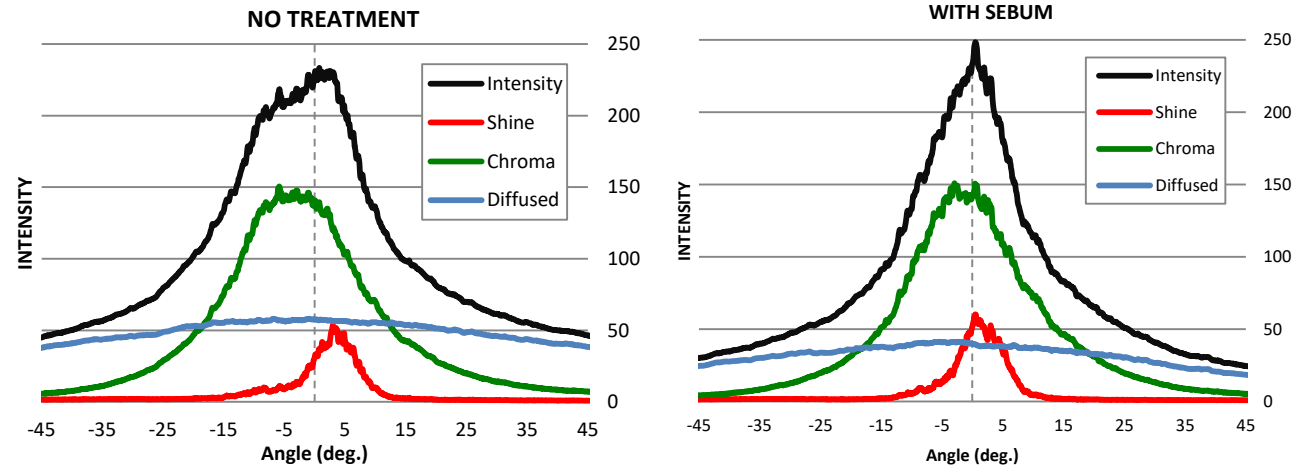
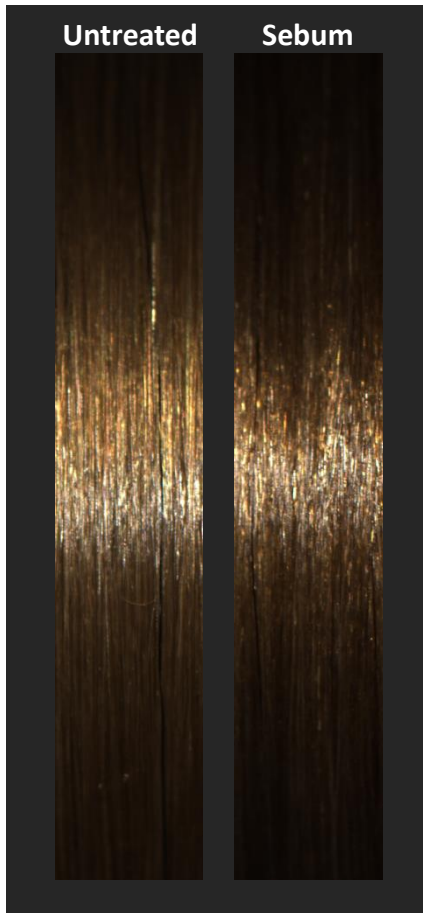
Export in Excel (for numerical data and profiles)
Export in .png (for images)



VISION

Measurement						Lusters			
Study	Sub-Folder	Measurement	Position	Date	Exposure_times	BNT	ReichRobbins	Gulolet	Spec_Int
December2022	Dec03	1	0	12/3/2022 2:02 PM	121.973336 600.371811 2315.481165	35.17828	152.274628	1022.844604	843.503296
December2022	Dec03	1	3	12/3/2022 2:03 PM	103.920413 647.412312 2263.713869	38.273602	184.992172	1077.250977	868.1521
December2022	Dec03	1	6	12/3/2022 2:04 PM	102.746299 951.244047 2665.125669	38.708515	171.343567	1057.281006	899.797607
December2022	Dec03	1	9	12/3/2022 2:05 PM	116.537391 967.417405 2853.245750	34.610867	170.271774	1041.086426	861.396366
December2022	Dec03	9	0	12/3/2022 2:08 PM	100.253967 68.416506 178.687311	4.173306	8.894312	138.640335	3824.66796
December2022	Dec03	9	3	12/3/2022 2:08 PM	88.986874 70.297504 183.996318	4.348994	9.156375	139.964401	3754.91186
December2022	Dec03	9	6	12/3/2022 2:09 PM	86.374435 65.774901 191.385406	4.526393	9.63531	146.10289	3843.09497
December2022	Dec03	9	9	12/3/2022 2:09 PM	79.758653 62.220273 197.291394	4.889397	10.296776	151.376648	3852.18139
December2022	Dec03	5	0	12/3/2022 2:05 PM	101.995322 128.627524 729.967602	16.460238	46.34507	506.937012	1679.67883
December2022	Dec03	5	3	12/3/2022 2:06 PM	105.702327 122.911606 738.568068	16.012339	50.572514	539.41095	1667.51855
December2022	Dec03	5	6	12/3/2022 2:07 PM	92.853633 118.013703 786.828772	19.282604	51.755894	557.87915	1658.38147
December2022	Dec03	5	9	12/3/2022 2:07 PM	102.780960 115.722863 701.637880	17.959776	47.152813	522.39502	1606.45166

Example – Study of a hair treatment



Observations:

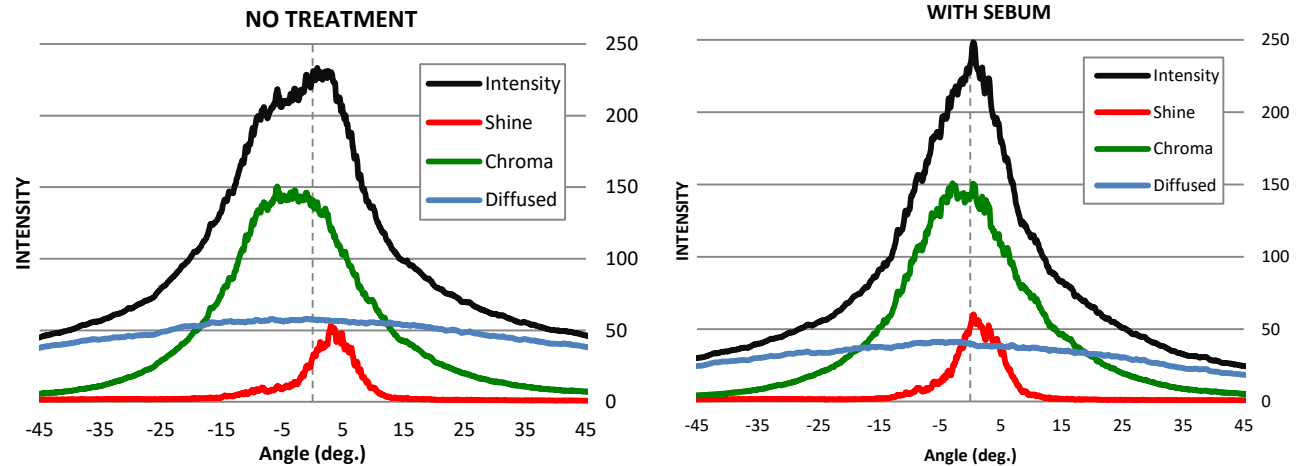
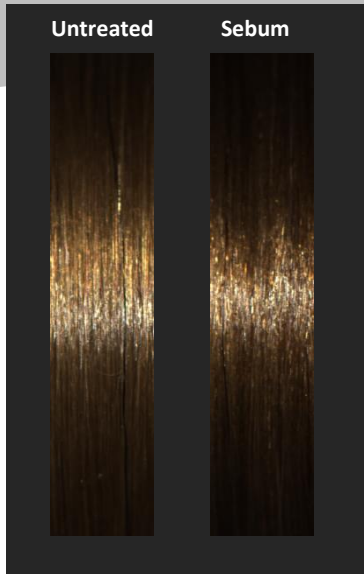
On the non-treated hair:

- the first and second reflections are well separated
- The first reflection is shifted towards the negative angles. This is due to the cuticle of hair.

On the treated hair:

- The first and second reflections now overlap more.
- The first and second reflections moved towards the zero angle position. The treatment filled the cuticle and the hair surface is now smoother.
- The shine slightly widened
- The chroma width decreased slightly
- The hair appears darker. The diffused light decreased significantly.

Example – Study of a hair treatment



	LUSTER		SPECULAR		SHINE			CHROMA			DIFFUSED	MISC.	
	BNT	Reich-Robbins	Width	Intensity	Width	Intensity	Center	Width	Intensity	Center	Intensity	Δ	Overlap
No Treatment	4.6	7.9	13.8	4995	4.9	589.5	3.5 deg.	14.8	4405	-4.3 deg.	4583	7.9 deg.	76.1 %
With Sebum	8	13.8	11.5	4687	5.1	572.8	1.0 deg.	13.5	4114	-1.7 deg.	3001	2.7 deg.	84.5 %
Variation (% , deg.)	+ 74.5 %	+ 74.6 %	- 27.5 %	- 6.2 %	+ 3.9 %	- 2.8 %	- 2.5 deg.	-9.2 %	- 6.6 %	+ 2.7 deg.	- 34.5 %	- 66 %	+ 11 %

Luster is increased

Specular width decreased mostly because of increased overlap between Shine and Chroma

Strong diffused intensity decrease (wet effect)

Samba Hair System

Conclusions

- SAMBA Hair is a robust, turn-key system for Shine, Chroma, Diffused and Luster quantification
- Acquisition, data management, preview and export is extremely simple for an improved user experience
- Additional automation enables easy accumulation of data for statistically significant results

Thank you !

For further questions
feel free to contact us :



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