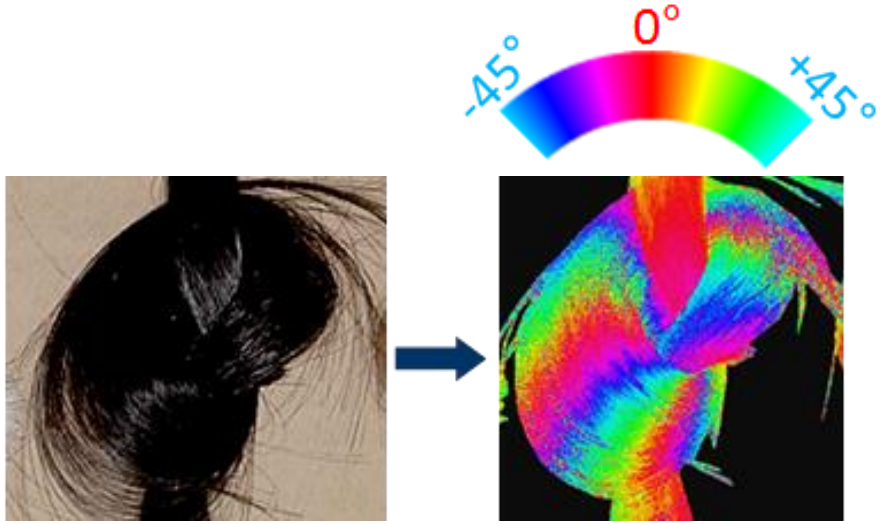
RUMBA

Polarization imaging for fiber orientation measurement

RUMBA Sensor

Laptop PC with pre-loaded software + Controller



Fiber orientation extraction/display

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In-vivo/In-vitro

Rumba in-vivo	Rumba Laboratory set-up
	
Tripod (included) for in-vivo measurement	**Lab Setup (included) for measurement on hair tresses**

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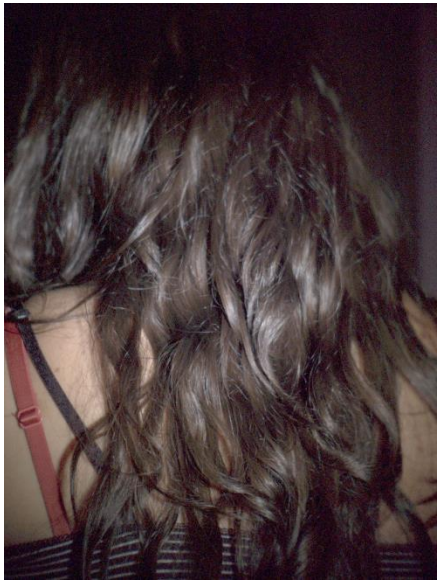
Shape/Alignment

Spatial distribution of the hair fibers

(straight to curly + styling)



Existing technique: Fiber/Hair Orientation Measurement → conventional imaging + image analysis/image processing

New technique: Measurement of physical parameter related to the orientation of the fiber using polarization analysis/imaging

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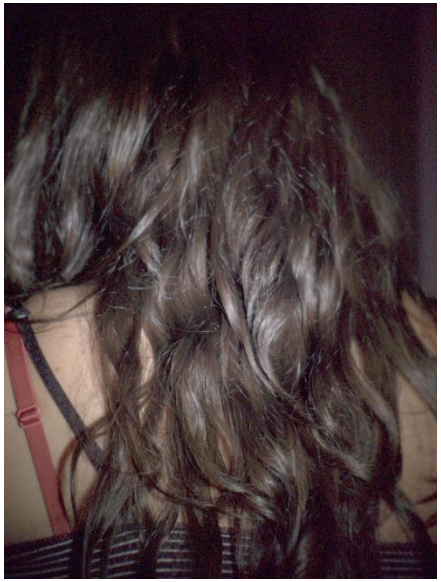
Example of in-vivo measurement (panelist)

Intensity (Visible) Conventional Image



Intensity image (NIR)

Color coded Orientation image

RUMBA Uses NIR LEDs => Even dark hair are transparent and can be measured

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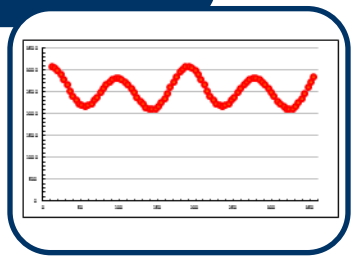
Measurement process

Acquisition of raw images < 1 second

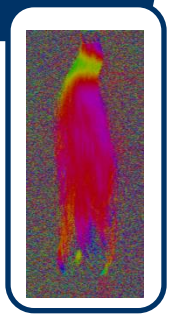
Extraction of modulated signal pixel by pixel



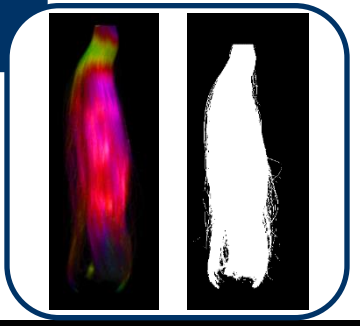
Deduction of angle θ pixel by pixel

1.2	5.9	2.3
10.2	-38.5	0.5
0.2	10.3	23.1

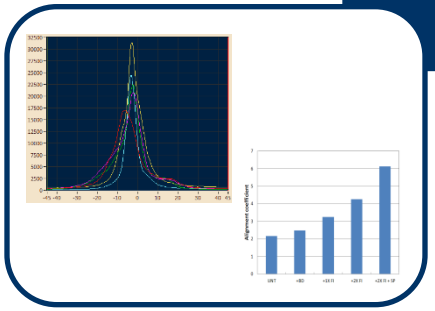
Color coding of angle for display pixel by pixel



Extraction of background and fusion



Data analysis /quantitative data



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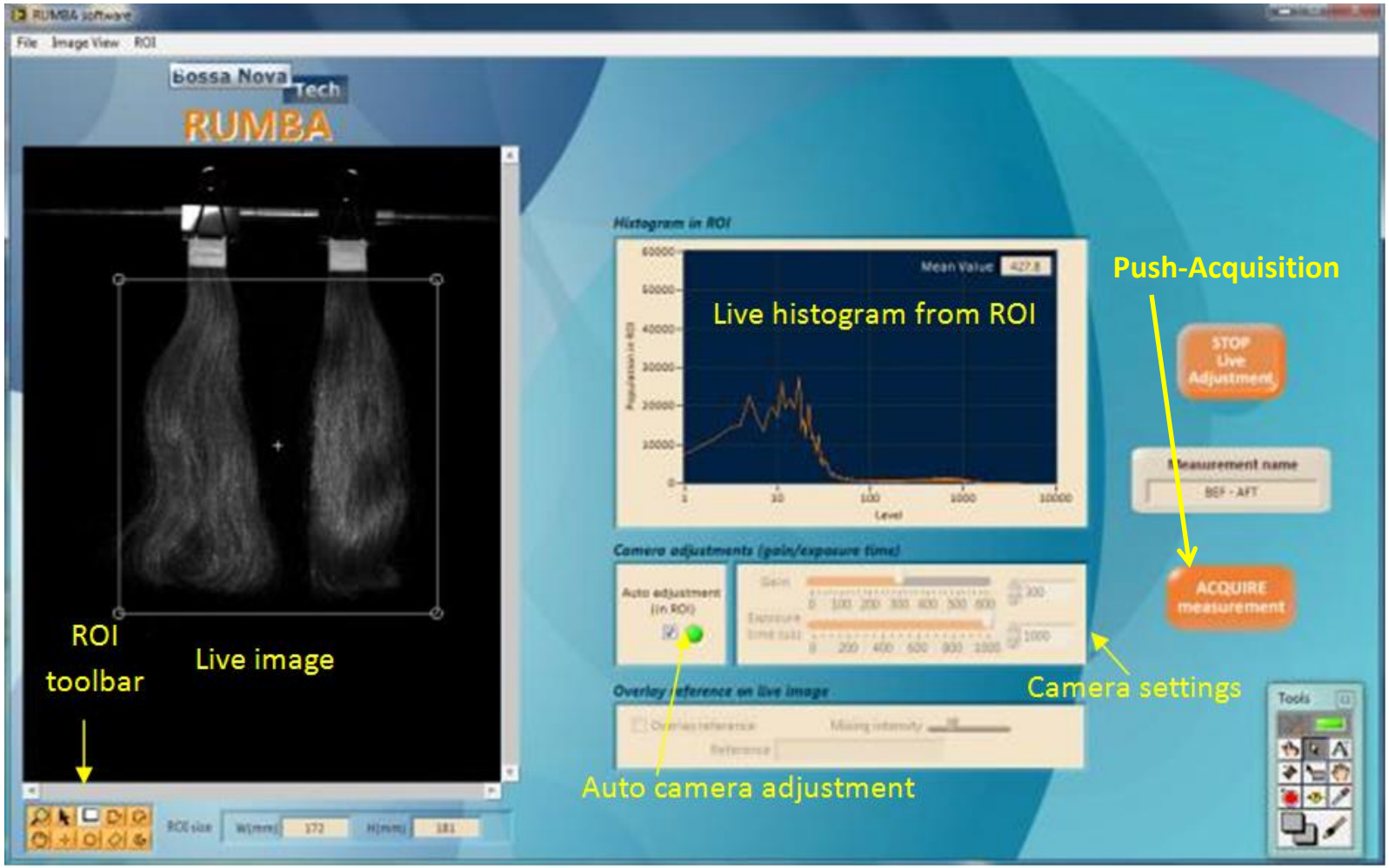
Live Image – Auto Exposure



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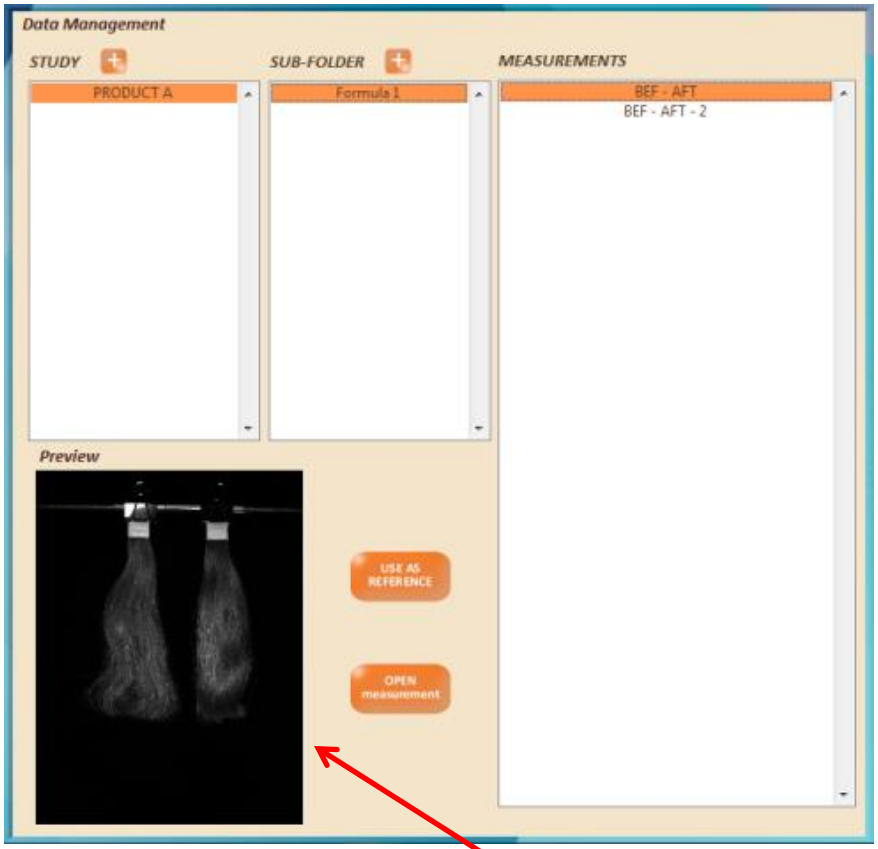
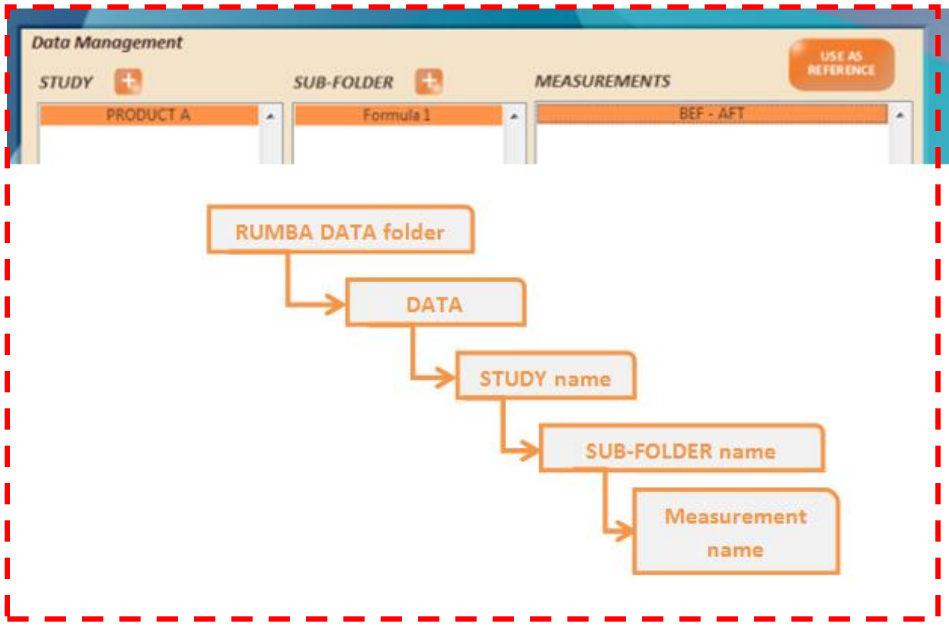
Data Management



Preview



All previous measurements are easily accessible

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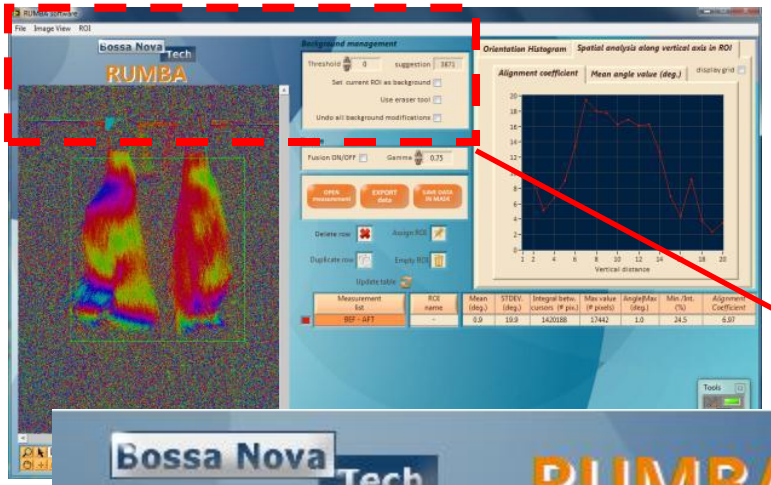
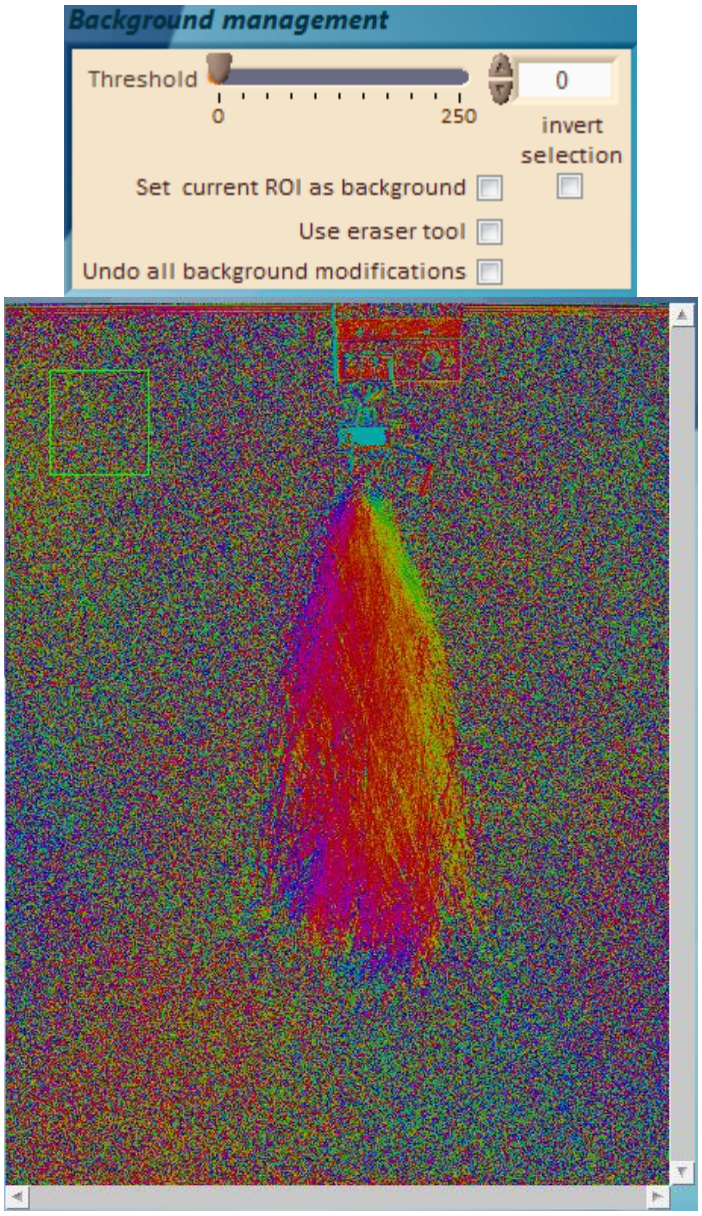
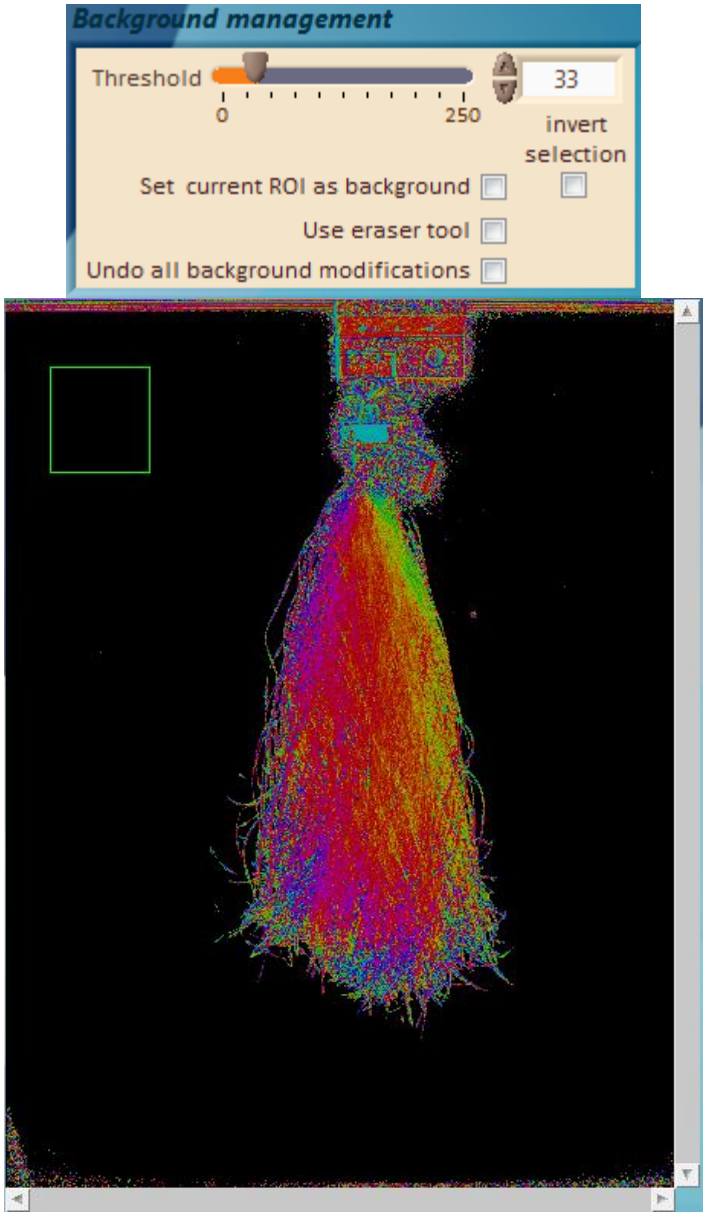
Background extraction using the software



Detachable background panel and the threshold tool included in the software allows for easy background extraction





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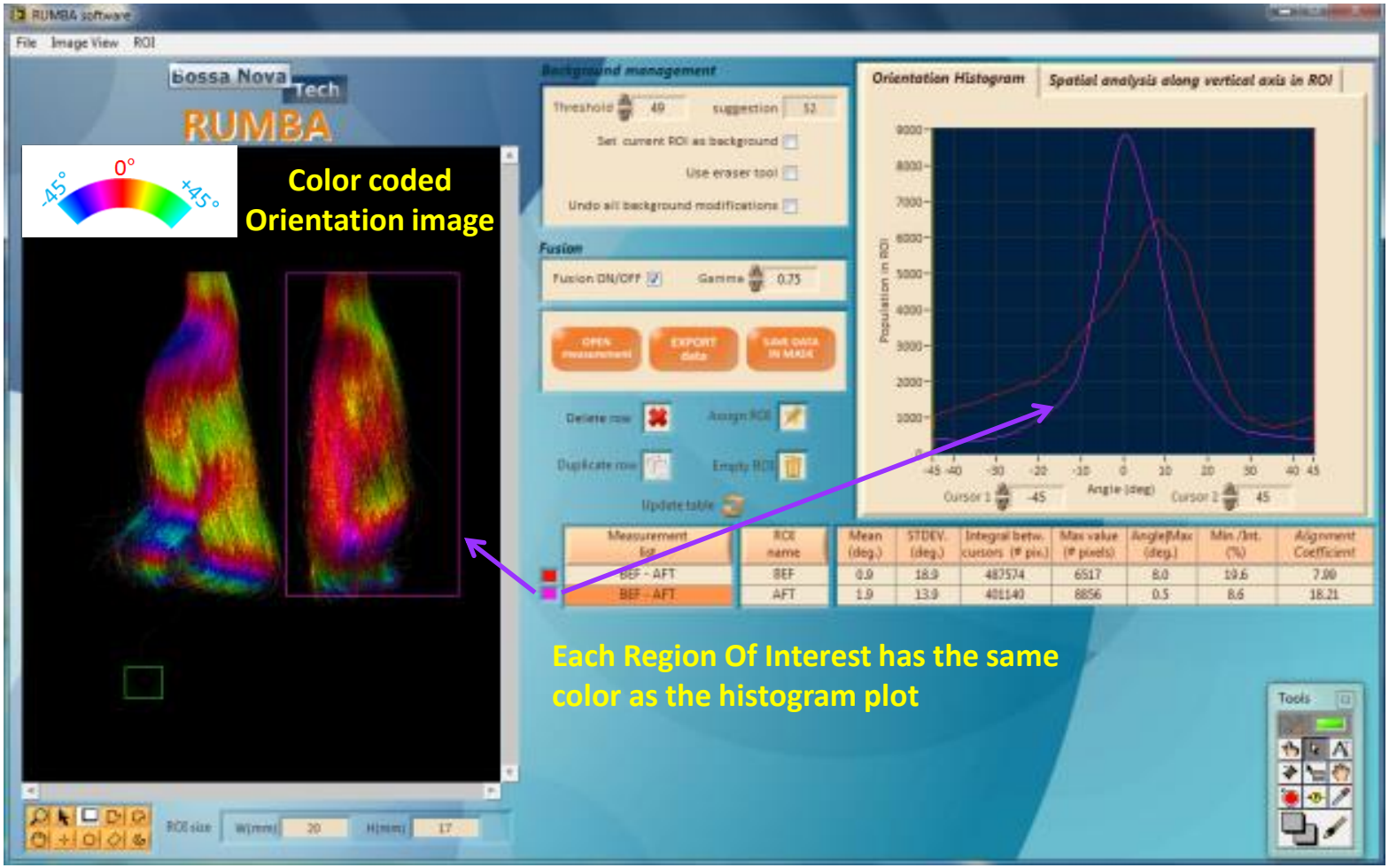
Comparison-Analysis [Histograms]



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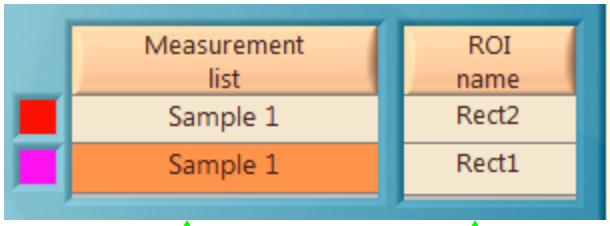
Data Extraction



Mean (deg.)	STDEV. (deg.)	Integral betw. cursors (# pix.)	Max value (# pixels)	Angle|Max (deg.)	Ratio Min/Int (%)	*Alignment Coefficient*
-0.1	6.7	61159	2174	0.5	0.6	11.13
-0.6	8.2	152602	5092	0.5	2.0	8.40

Up to 12 Measurements can be loaded (or duplicated)

Regions of Interest can be assigned to any Measurement

Mean Angle in the ROI

Standard Deviation of the Angular Distribution in the ROI

Area covered by the ROI. Size calibration possible with "real" units [mm²]

MAX Histogram

MAX Angle

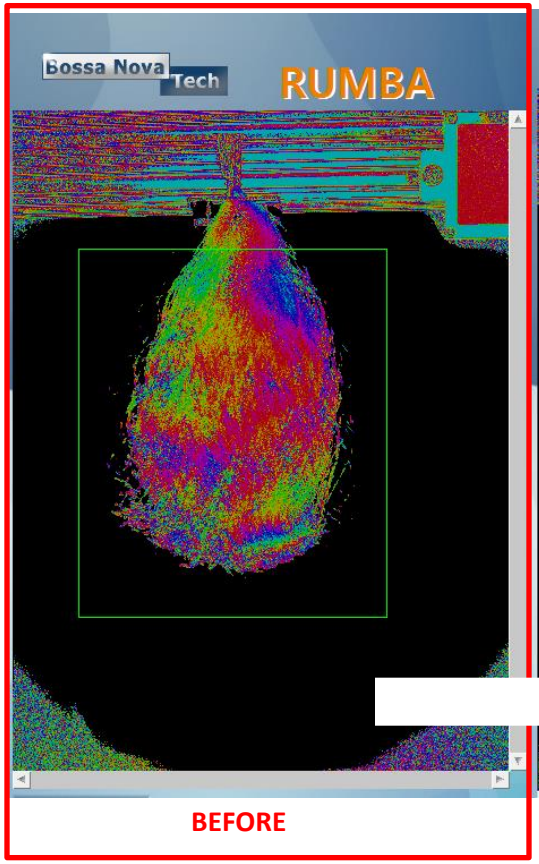
Ratio Min/Integral

Proportional to 1/STDV

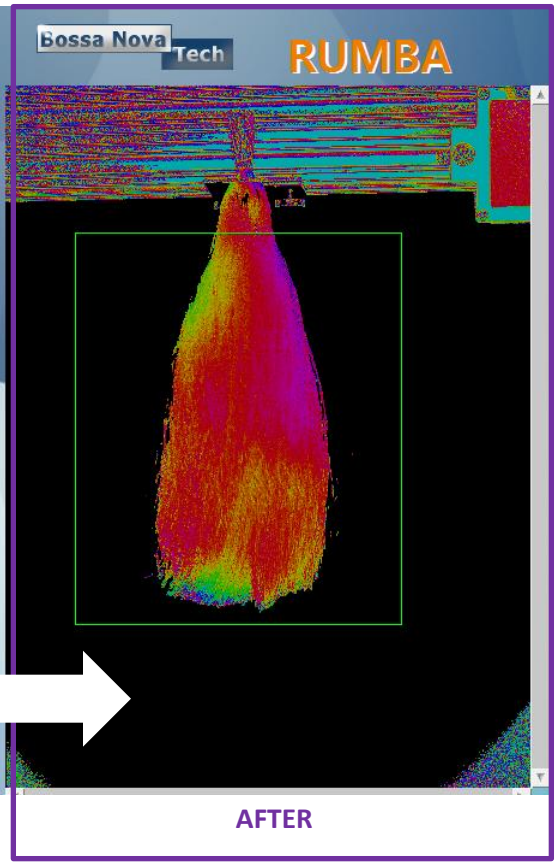
- Hair Alignment Measurement

- Before treatment

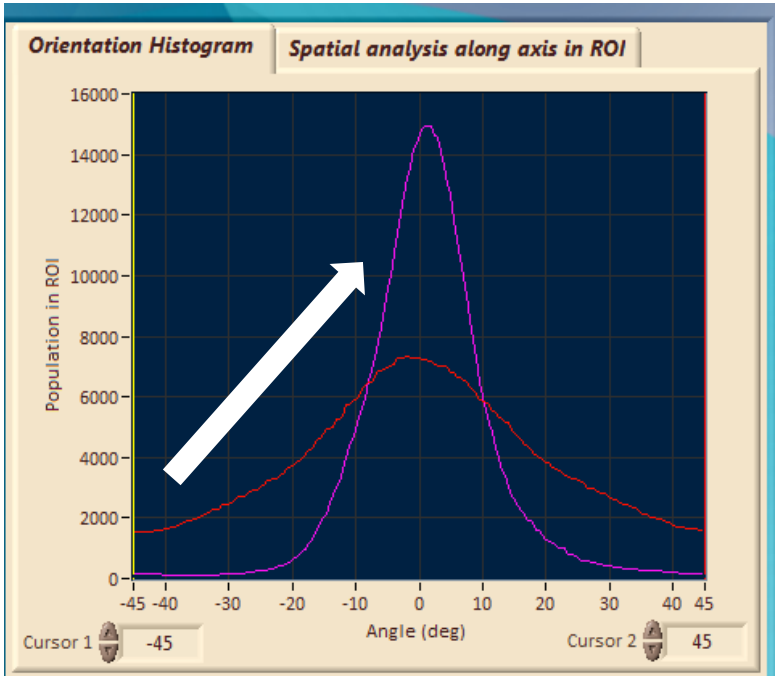
- After treatment



BEFORE



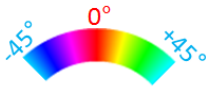
AFTER



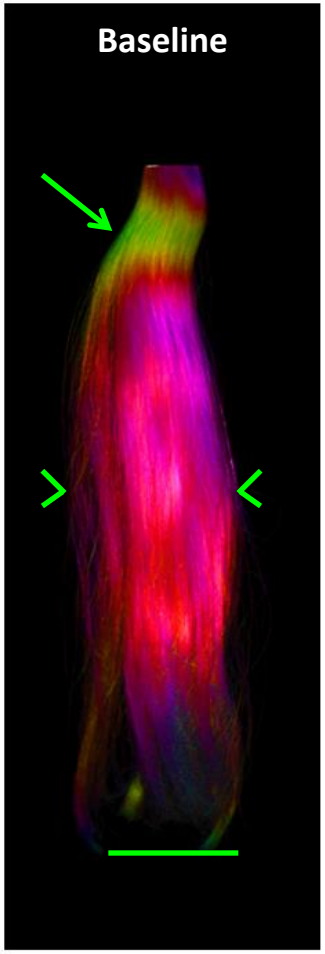
The histogram is thinner, the fiber are better aligned.

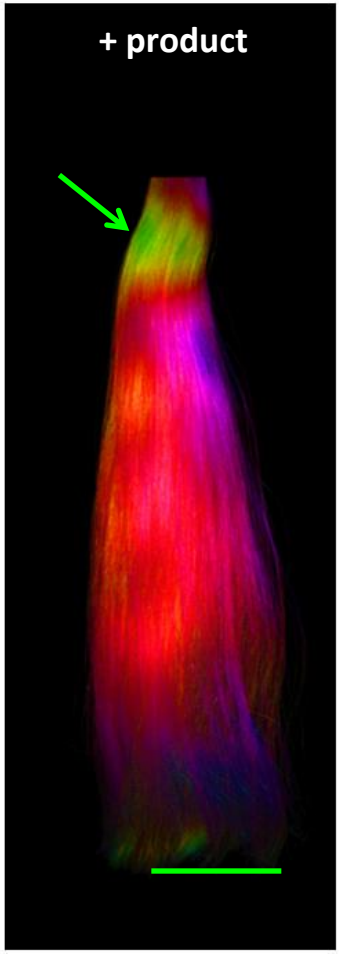
Measurement list	ROI name	Mean (deg.)	STDEV. (deg.)	Integral betw. cursors (# pix.)	Max value (# pixels)	Angle|Max (deg.)	Min /Int. (%)	*Alignment Coefficient*
F1R	-	0.2	20.1	707010	7312	-2.0	39.3	6.71
F1T	-	1.4	10.1	567102	14939	1.0	3.5	29.36

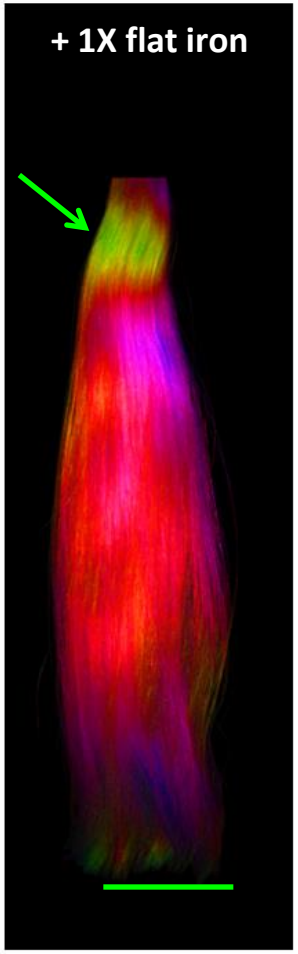
The alignment coefficient reflects the increase

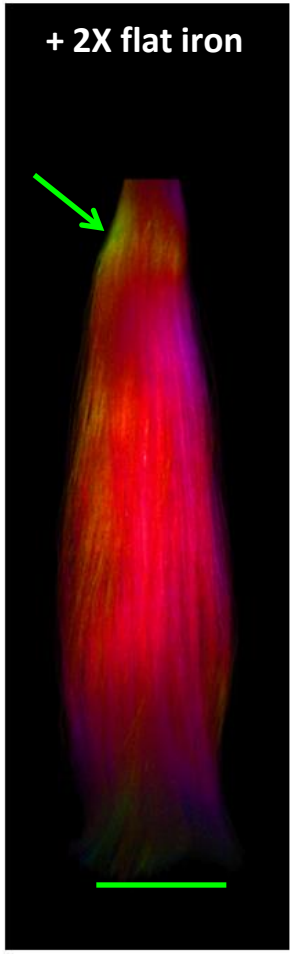


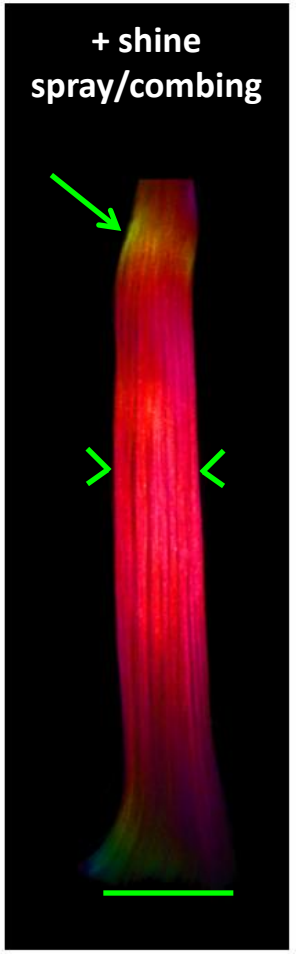
Color coding shows visual differences











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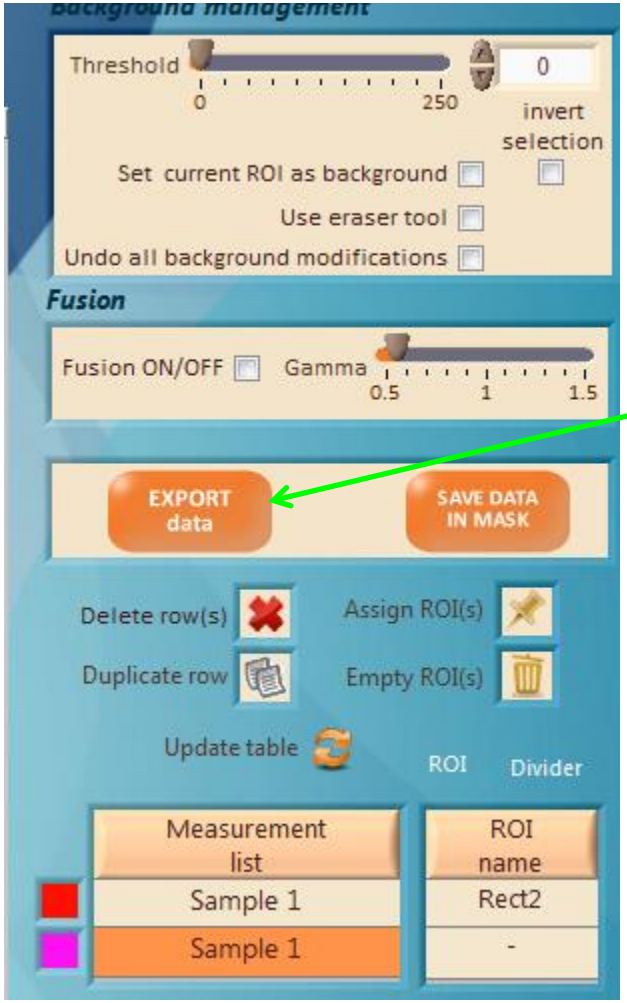
Data Export



Name	Region Of Interest	ROI width (mm)	ROI height (mm)	Mean (deg.)	STDEV. (deg.)	Integral (# pixels)	Max (# pixels)	Angle/ (deg
Sample 1	Rect2	740	1089	-0.1	6.7	61159	2174	0.5
Sample 1	-	682	3465	-0.7	8.6	179482	5679	0.5

All Data can be exported in Excel spreadsheet

Angle (deg.)	Sample 1
ROI	Rect2
-44.5	3
-44	6
-43.5	6
-43	7
-42.5	7
-42	7
-41.5	6
-41	6
-40.5	5
-40	5
-39.5	5
-39	5
-38.5	5
-38	5
-37.5	6
-37	5
-36.5	5

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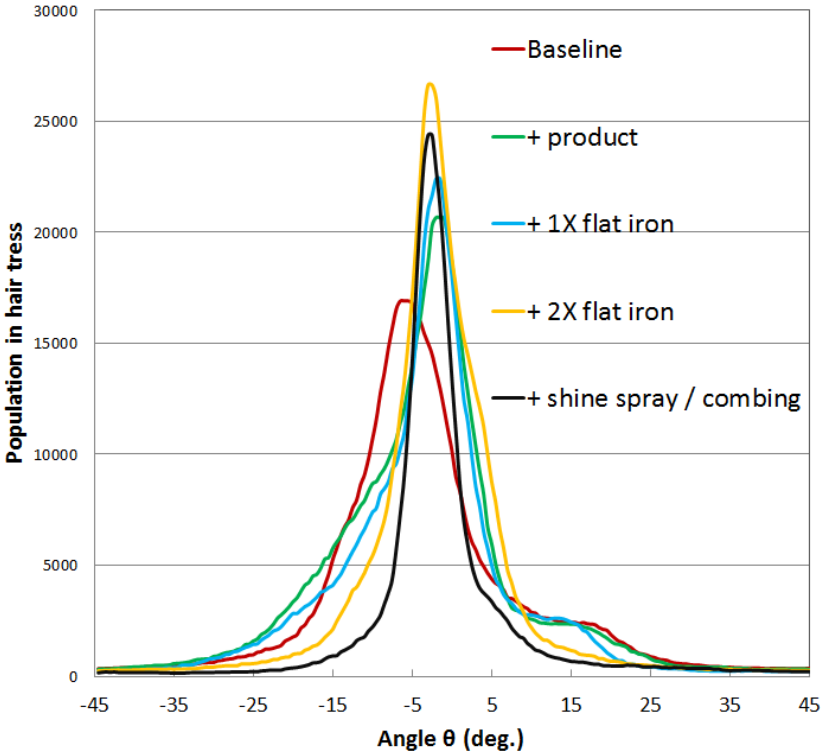
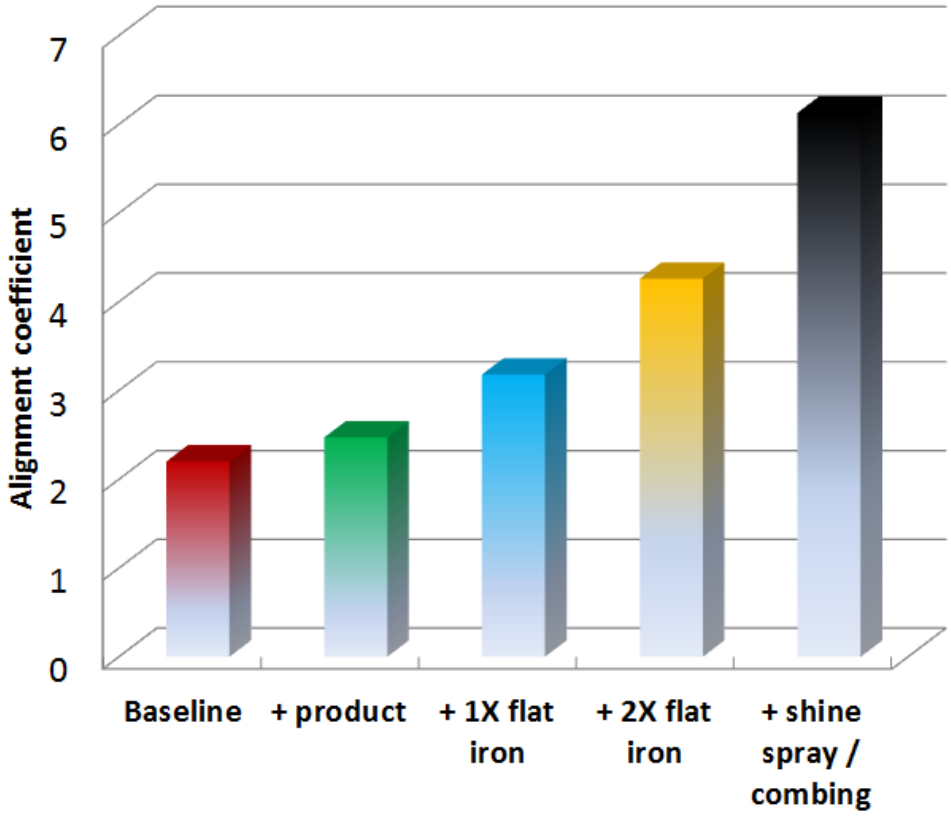
Quantitative data allowing objective comparison of Alignment

Histograms:
Angular distribution in the Region Of Interest

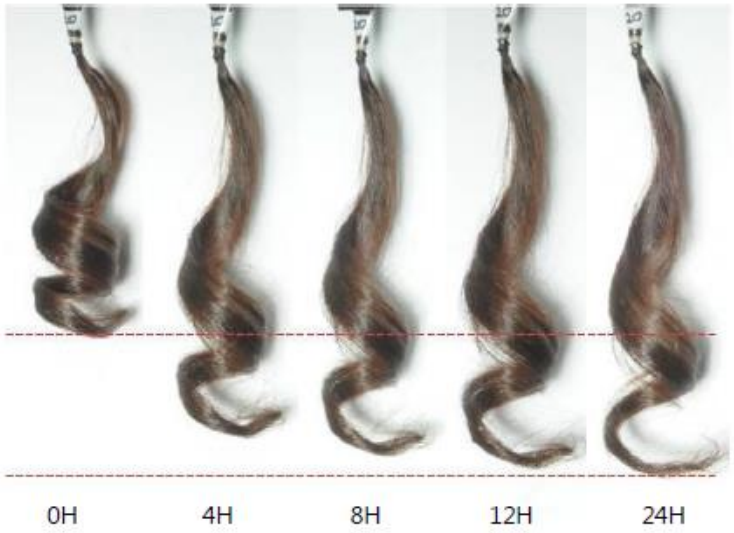


Alignment coefficient = $\frac{Max}{Area} \cdot \frac{1}{\text{Stdev.}}$



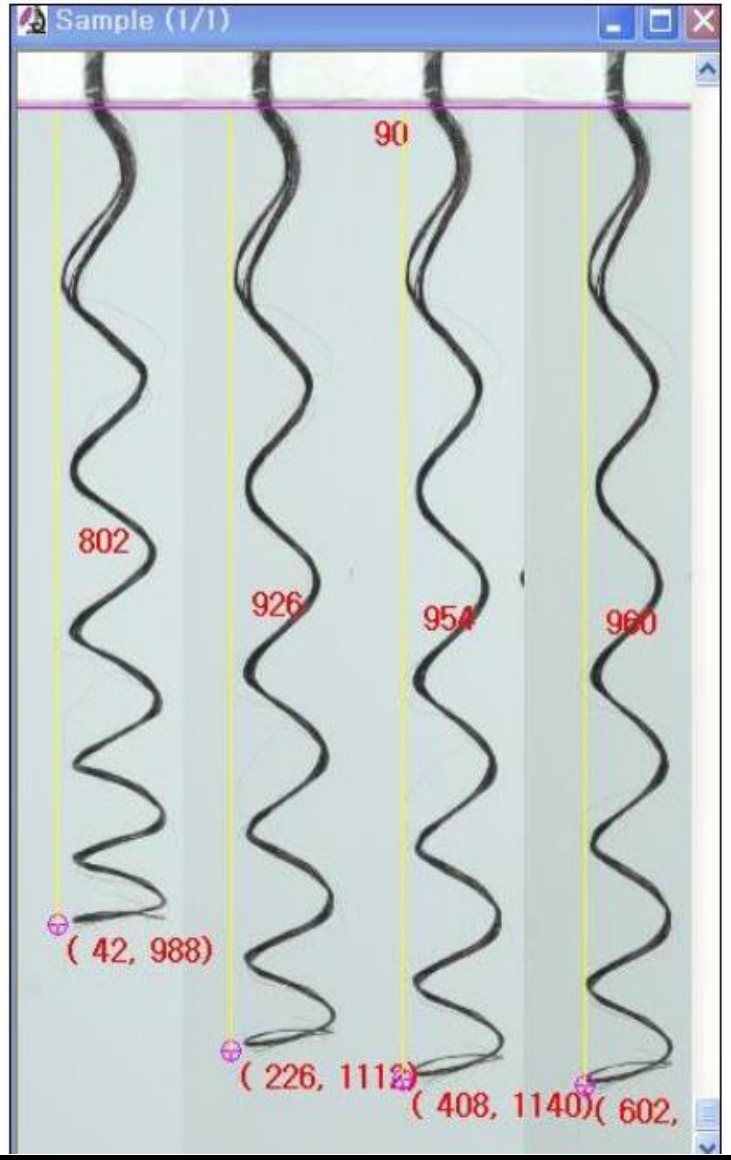
- Hair curling Measurement

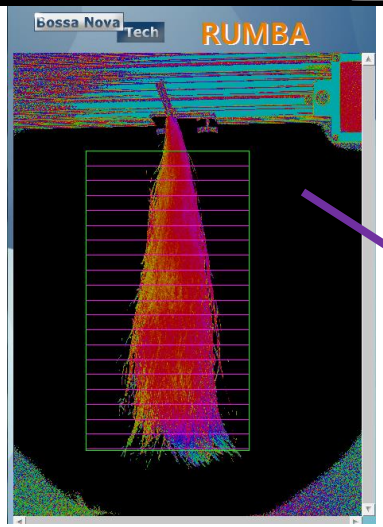
- Wave I

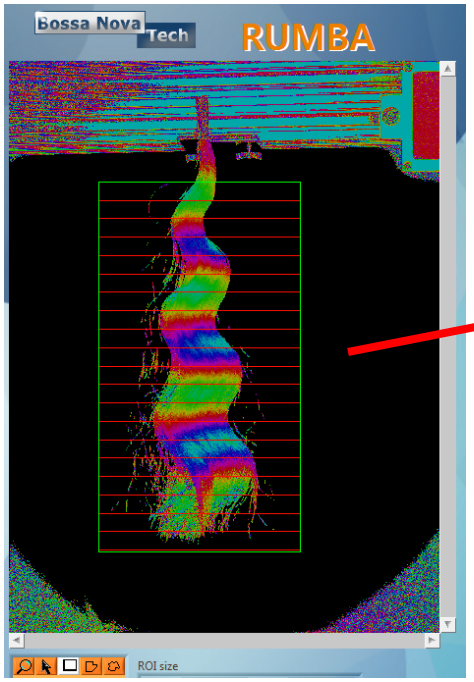


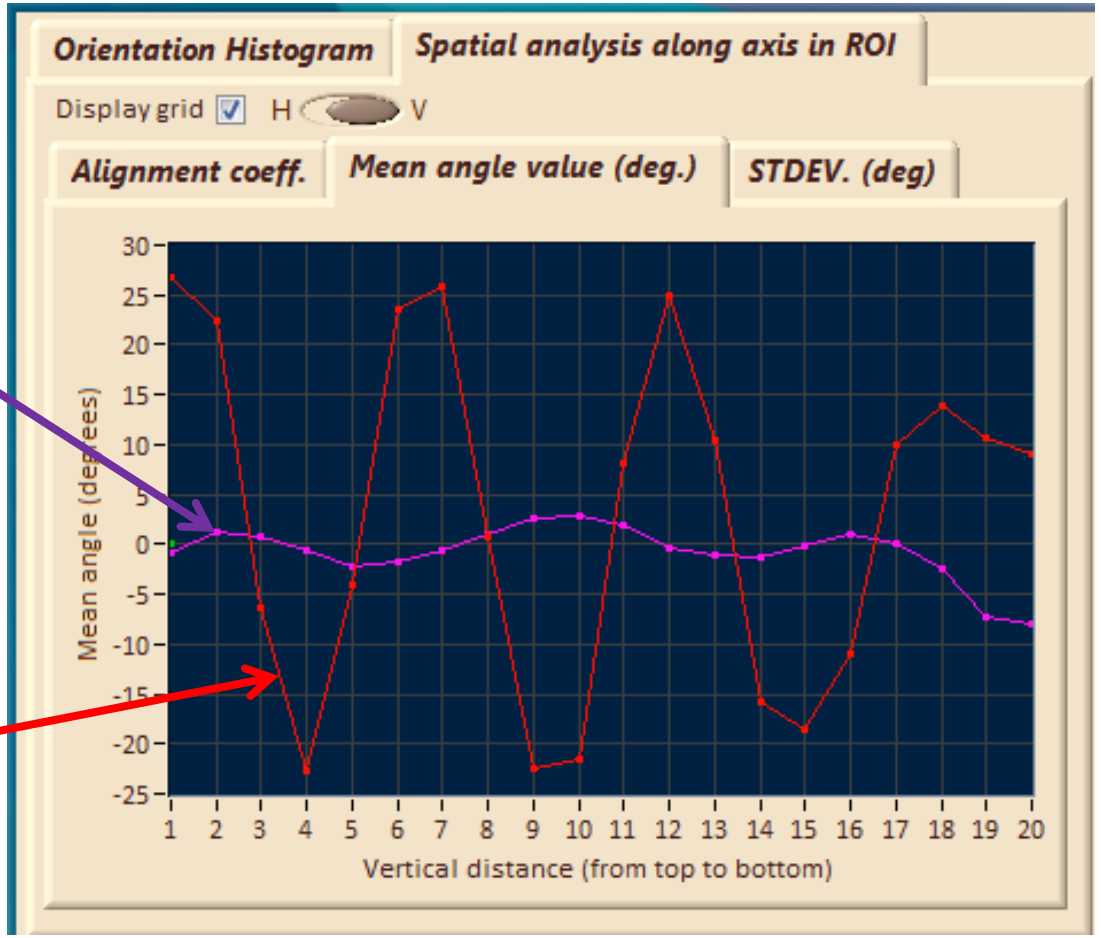
- Wave II

- Wave III



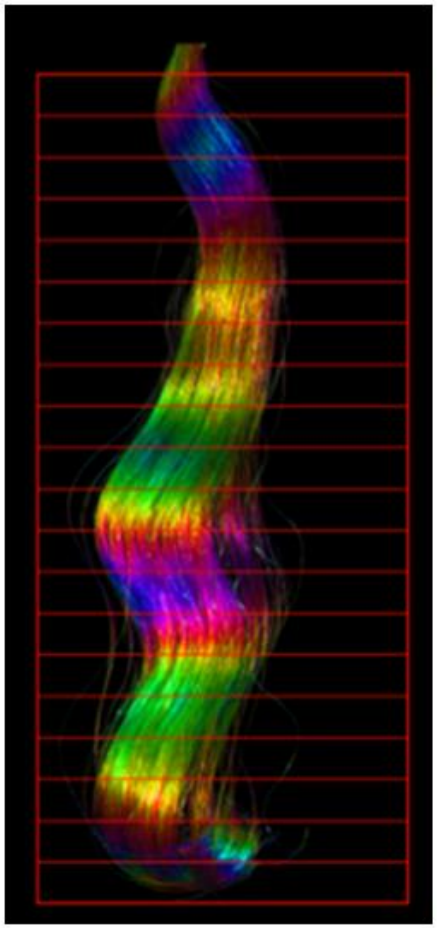


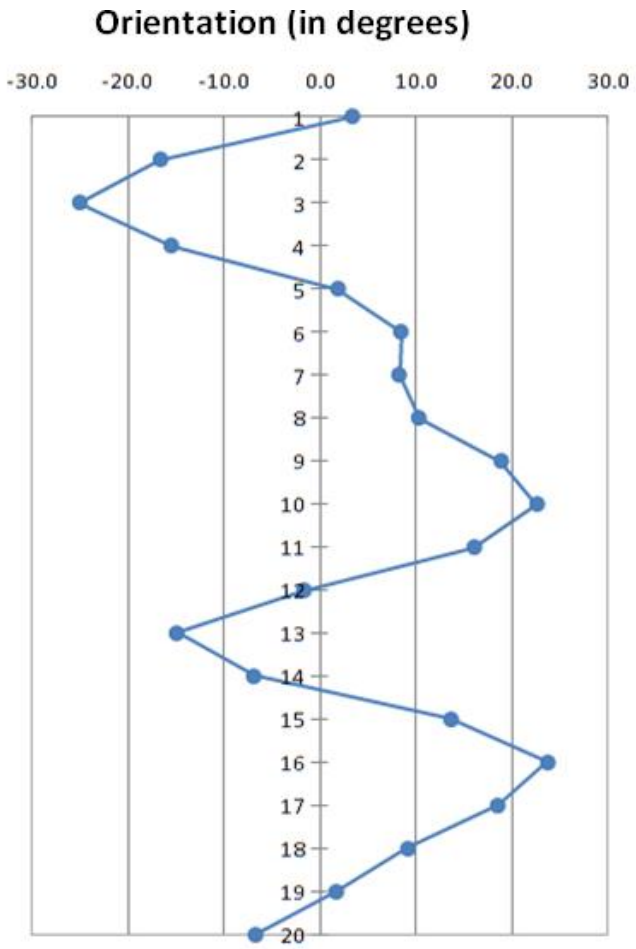




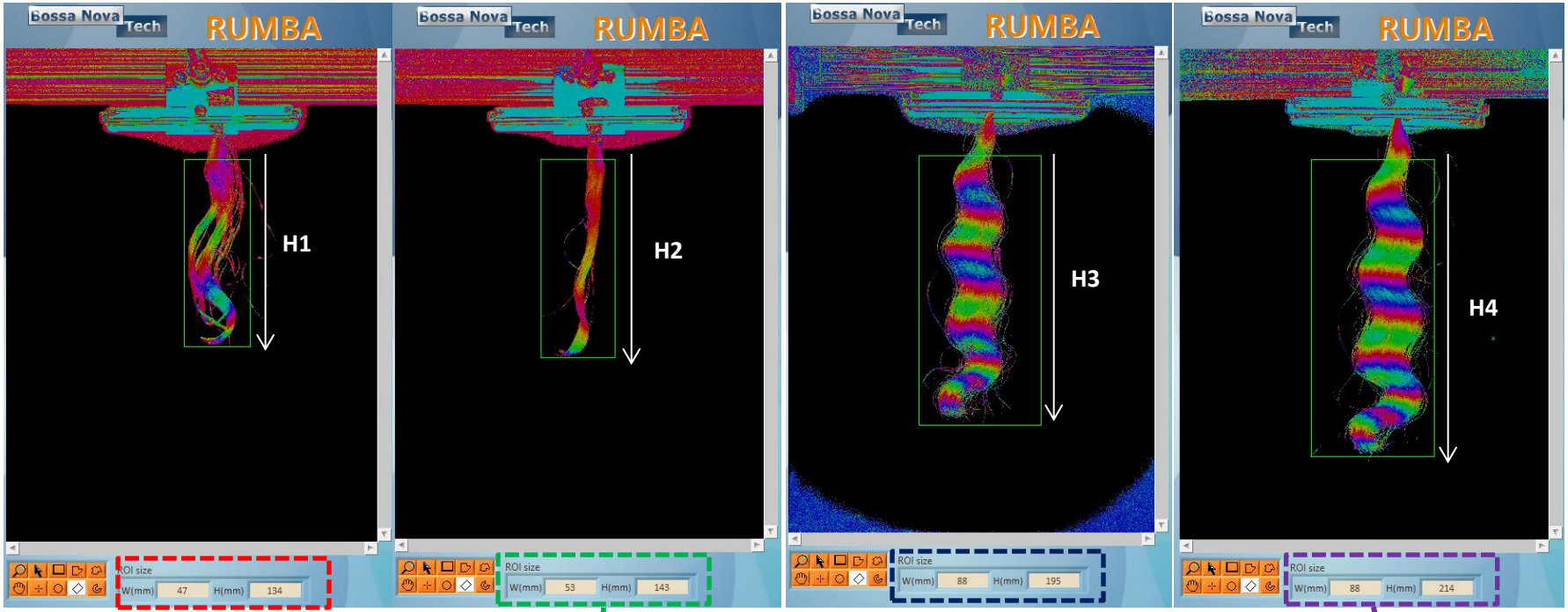
RUMBA can perform spatial analysis to count the number of cycles or the amplitude of the curls

RUMBA
Spatial Analysis

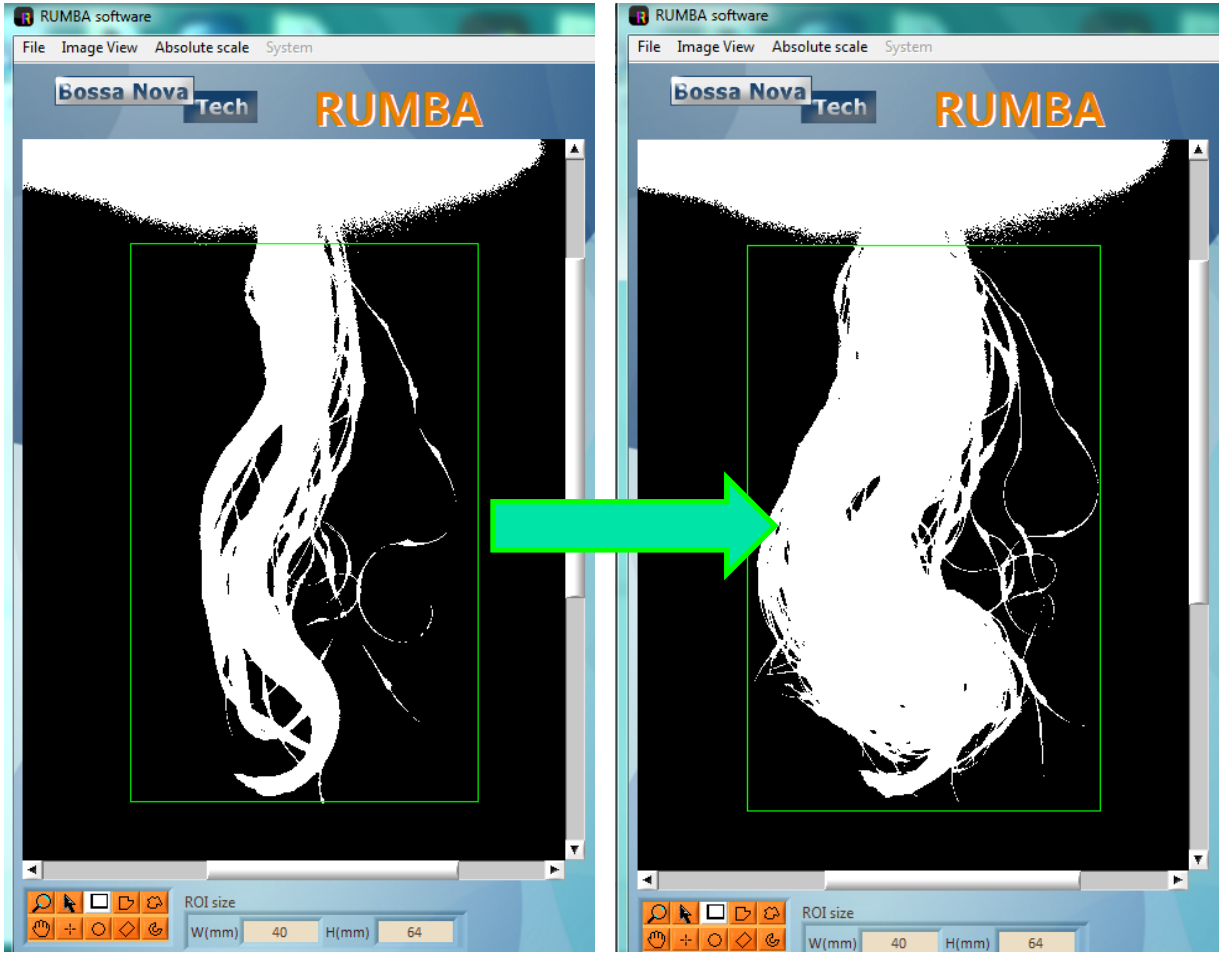


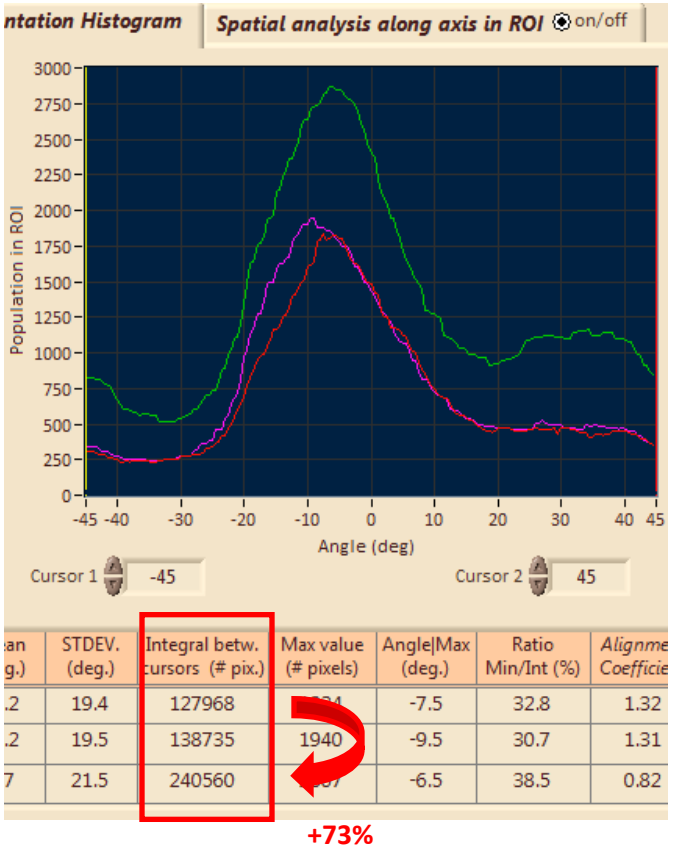


The ROI can be divided into "boxes" and provide spatial analysis of Mean Angle or STDV parameters.



RUMBA provides the size of the Region of Interest in Real units (mm), so it is possible to track extension/shrinking of hair swatch





The RUMBA software can track the projected volume of the tress by counting the data pixels (the background is extracted).

Timed measurements allows the user to start a study at t=0 and generate auto-measurements every x Minutes.

RUMBA
Conclusions

- **RUMBA is a robust, turn-key system for fiber orientation measurement**
- **Thanks to the complete lab setup, RUMBA provides accurate and repeatable in-vivo and in-vitro measurements**
- **Data management and comparison is very easy thanks to a user friendly RUMBA software**

Thank you!