

# Surface Analyzer TiVi95 User Manual

User Manual 3.2 Version 3.2 February 2019

**PIONEERS IN TISSUE VIABILITY IMAGING** 

#### Dear Valued Customer!

Welcome to the WheelsBridge TiVi95 Skin Surface Analyzer system intended for automatic analysis of cellulite appearance. The TiVi95 Skin Surface Analyzer was designed especially for observer-independent analysis of cellulite in association with evaluation of skin care products and follow up of treatment regimes.

The TiVi95 Skin Surface Analyzer utilizes a highly sensitive digital camera equipped with polarization filters making it possible to suppress direct surface reflections from the skin surface. The versatile system software – based on the MATLAB® high performance language for technical computing – allows for rapid and easy capturing and analysis of images. Among the many useful features of the TiVi95 Skin Surface Analyzer software the following are of particular interest:

- Automatic capturing of photos.
- Region of Interest analysis.
- Automatic tracking of cellulite dimples.
- Library function to display up to 6 photos simultaneously.
- *Trend monitoring.*
- Surface Reflection Analysis

We are convinced that the Surface Analyzer TiVi95 will be a productive tool in the assessment and follow-up of cellulite appearance following treatment with skin care products.

Thank you for choosing the WheelsBridge TiVi95 Skin Surface Analyzer.

WheelsBridge AB

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The *Surface nalyzer* is not registered as a Medical Device. It is intended for research applications only.

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## 1. INTRODUCTION

Most women and some men show signs of cellulite where the skin of the lower limbs, abdomen and the pelvic region becomes dimpled. The causes of cellulite are not fully understood, but hormonal components are thought to play a dominant role in its formation. Several genetic factors promote the development of cellulite as do lifestyle factors. A number of therapies for treatment of cellulite are available, but empirical evidence of the efficacy of these treatment regimes is limited, mainly due to lack of methods for quantification of cellulite appearance. The *TiVi95 Skin Surface Analyzer* is a software package that analysis important features of cellulite and associated skin dimples based on photos captured by polarization spectroscopy camera technology.

The intended use of the *TiVi95 Skin Surface Analyzer* is to analyse the appearance of cellulite in laboratory applications. It is not yet approved for the diagnosis and treatment

#### 2. OPEARATING PRINCIPLE

The TiVi95 Skin Surface Analyzer operates in the following way:

- 1. Photos of the actual skin area are captured before and after treatment.
- 2. These photos are uploaded to the *TiVi95 Skin Surface Analyzer* main window.
- 3. Regions of interest (**ROI**) are drawn around the cellulite area.
- 4. When the **ROI**s are displayed, the average intensities of the two photos are equalized.
- 5. Tracking of skin dimples starts automatically and analysis of local irregularities in intensity of the two photos are performed.
- 6. The cellulite areas are displayed in grayscale superimposed on the photos.
- 7. An **Improvement Index** is calculated to quantify the result of the treatment.
- 8. Up to six photos with superimposed cellulite areas can be displayed and compared in the **Library** window.
- 9. In the **Trend Analyzer** changes in **Improvement Index** of the six photos are displayed.
- 10. All basic recorded and calculated data can be stored in a MS Excel ® spread-sheet.

### **3. CELLULITE PARAMETERS**

The *TiVi95 Skin Surface Analyzer* automatically tracks areas with low and irregular intensities associated with skin dimpling. In the **Reference** photo (generally the photo captured before treatment) the cellulite areas are displayed in grayscale while the non-cellulite areas are displayed in colour. As default the threshold value in the **Reference** photo is set in such a way that 50% of the photo displays grayscale values (**Sensitivity** = 1).



In the **Second** photo (generally the photo captured after treatment) the average intensity is first made identical to that in the **Reference** photo. Applying the same threshold as in the **Reference** photo the cellulite areas in the **Second** photo can now be displayed in grayscale.





The **Improvement Index** when going from the Reference photo to the Second photo is calculated according to:

#### **Improvement Index =**

1 - (Relative grayscale area in **Second** photo / Relative grayscale area in **Reference** photo)

When the relative grayscale area in the **Second** photo is zero, the **Improvement Index** = 1 (maximal improvement) and when the relative grayscale area in the **Second** photo is identical to that of the **Reference** photo, the **Improvement Index** = 0 (no improvement).

In the **GETTING STARTED** section these and other features are further explained by way of an example.

#### **3. GETTING STARTED**

The basic features of the *TiVi95 Skin Surface Analyzer* are probably best explained by way of an example. In the following example it is assumed that the photos *Before-0001.jpg and After-0001.jpg* have been captured by a camera with polarizing filters and stored in the *TiVi95demonstration* folder. These photos demonstrate cellulite appearance before and after treatment at somewhat different exposure. The task is to calculate the **Improvement Index** for the actual treatment procedure.

🚺 TiVi95 Skin Surface Analyz	er 3.1			_ <b>_</b> ×
Surface Reflectivity Manua	al About Demo Assistant			
Wheels Bridge				
	Photo 1		Photo 2	
Name:	Date:	Name:	Date:	
Load Photo 1	Display Photo 1	Load Photo 2		Display Photo 2
Show ROI 1	Display Mixed 1	Show R012		O Display Mixed 2
Save ROI 1		Save ROI 2		
	0			
Clear All	Library	1 Improvement In	dex:	Close

1. Open the TiVi95 Skin Surface Analyzer main window.

2. Click **Load Photo1** and navigate to the *TiVi95demonstration* folder. Double-click the *Before-0001 file*. The **TiVi95 Surface Analyzer** window should now look like.

🕽 TiVi95 Skin Surface Analyzer 3.1						
Surface Reflectivity Manual About Demo Assistant	ĸ					
Wheels Bridge						
Photo 1	Photo 2					
Name: Before-0001 Date: 26-Aug-2009 18:59:01	Name: Date:					
Load Photo 1       O Display Photo 1	Load Photo 2       O Display Photo 2					
Show RDI 1 O Display Mixed 1	Show R012 Display Mixed 2					
Save ROI 1	Save ROI 2					
Sensitivity						
Clear All Library	1 Improvement Index: Close					

3. Click the **Load Photo 2** button and double-click the *After-0001* file. The *TiVi95 Skin Surface Analyzer* window should now look like:

Surface Reflectivity Manual About Demo Assistant           Wheele Bridge           Photo 1
Wheels Bridge       Photo 1   Photo 2
Photo 1 Photo 2
Name: Refore-0001 Date: 26-Aun-2009 18:59:01 Name: After-0001 Date: 26-Sen-2009 12:57:01
Load Photo 1
Show R01 Display Mixed 1 Show R012 Display Mixed 2
Save R011 Save R012
Clear All Library Clear All Library Clear All Library Clear All Close

4. Draw a Region of Interest (**ROI**) by placing the mouse courser at the upper left corner of the **ROI**, pressing the left mouse button and dragging the mouse to a point representing the lower right corner of the **ROI**, where the left mouse button is released. The *TiVi95 Skin Surface Analyzer* window should now look like:

🛃 TiVi95 Skin Surface Analyzer 3.1						
Surface Reflectivity Manua	al About Demo Assistant			ע		
Wheels Bridge						
	Photo 1		Photo 2			
Name: Before-0001	Date: 26-Aug-2009 18:59:01		Name: After-0001	Date: 26-Sep-2009 12:57:01		
Load Photo 1	Oisplay Photo 1		Load Photo 2	Oisplay Photo 2		
Show ROI 1	Display Mixed 1		Show ROI 2	O Display Mixed 2		
Save ROI 1			Save ROI 2			
Clear All	Sensitivity		1 Improvement Inde	BX: Close		

5. Draw a similar **ROI** over approximately the same region in **Photo 2**.

V TiVi95 Skin Surface Analyzer 3.1	
Surface Reflectivity Manual About Demo Assistant	لا
Wheels Bridge	
Photo 1	Photo 2
Name: Before-0001 Date: 26-Aug-2009 18:59:01	Name: After-0001 Date: 26-Sep-2009 12:57:01
Load Photo 1   O Display Photo 1	Load Photo 2   O Display Photo 2
Show ROI 1 O Display Mixed 1	Show R012 O Display Mixed 2
Save ROI 1	Save ROI2
Clear All Library	1 Improvement Index: Close

6. Click the **Show ROI 1** and then the **Show ROI 2** button. The cellulite areas in the two photos are now displayed in grayscale and the **Improvement Index** is calculated to 0.98.

	Photo 1	Photo 2	
allen W.			
Name: Before-0001	Date: 26-Aug-2009 18:59:01	Name: After-0001 Date: 26-S4	p-2009 12:57:01
Load Dhote 1		Load Photo 2	Dispidy Photo 2
Load Photo 1	Display Proto 1     Display Mixed 1	Lindo Show ROL	Display Mixed 2

- 7. Click the **Display Photo 1** and **Display Photo 2** button to display the original ROI areas without the cellulite areas superimposed.
- 8. Click the **Display Mixed 1** and **Display Mixed 2** button to display the original ROI areas with the cellulite areas superimposed.
- Click the Save ROI 1 button to save the ROI 1 photo. Insert "A" in the Filename edit box and click the Save button. The ROI 1 is now saved under the name *Cell\_A\_Before-0001*. Files with prefix *Cell* can be read into the Library.
- 10. Click the Library button to open the empty Library window.

🛃 TiVi95trend		
Display Photos		-
		_
Sensitivity O Mixed		
Load Photos	Close	

- 11. Click Load photos to open the Pick a file window. Navigate to the *TiVi95demonstration* folder and select *Cell\_A\_ce-0001* to *Cell\_A\_ce-0005* by first clicking on the *Cell\_A\_ce-0001*, then pressing the shift button on the computer keyboard, while the *Cell\_A\_ce-0005* file is selected. Alternatively individual files can be selected while pressing the Ctr button on the computer key-board, while clicking on the actual file name.
- 12. Click the **Open** button. The **Library** window should now look like:

/i95trend					
Display Photos					
	A star	and the second	A.		
Name:	Cell_A_ce-0001	Name:	Cell_A_ce-0002	Name:	Cell_A_ce-0003
Date:	26-Aug-2008 18:59:01	Date:	23-Oct-2008 14:48:01	Date:	13-Dec-2008 13:12:01
Imp Ind;	Reference	Imp Ind;	0.41	Imp Ind;	0.77
Name:	Cell_A_ce-0004	Name:	Cell_A_ce-0005		
Date:	15-Feb-2009 13:12:01	Date:	14-Jun-2009 09:26:01		
Imp Ind;	0.93	Imp Ind;	0.94		
Load Photos	Sensitivity	1	Mixed     Photo	Trend	Export Close

- 13. The **Library** window now shows five photos captured at different points in time during a treatment procedure. The gray areas represent the skin sites classified as cellulite areas and the **Improvement Index** (in red) reflects the improvement as the extension of the gray areas successively diminishes.
- 14. Click the **Trend** Button to display the **Improvement Index** trend.



15. Click the **Export** button to save the **Improvement Index** sequence to an MS Excel ® spread-sheet.

This concludes the **GETTING STARTED** session.

## 4. DETAILED DESCRIPTION

#### 4.1 Surface Analyzer TiVi95 Main window

When the *TiVi95Skin Surface Analyzer* is started in tool-box mode from inside the *TiVi700 Analyzer*, the *TiVi95 Skin Surface Analyzer* main window is displayed.

VIVI95 Skin Surface Analyzer 3.1								
Surface Reflectivity	Manual	About	Demo Assistant				۲	
Wheels Bridg	e							
Photo 1				Photo 2				
Name:		D	Date:		Name:	Date:		
Load Photo	o 1		Display Photo 1		Load Photo 2		Display Photo 2	
Show ROI	1		Display Mixed 1		Show ROI 2		Oisplay Mixed 2	
Save ROI	1				Save ROI 2			
L								
Clear All		Libra	Sensitivity		/ Improvement In	dex:	Close	
Clear All		Libra	iy (			uon.	Close	

- 1. Load Photo 1 to laod a new photo and display it in the Photo1 frame.
- 2. Show ROI 1 to show the ROI drawn in the Photo1 frame photo.
- 3. Save ROI 1 to save the ROI under a specific name. When the "*name*' is inserted in the Save as window File Name edit box. The complete name of the file will be "*Cell\_name\_oldname*". Only photos with the prefix "*Cell*" can be uploaded into the *TiVi95 Surface* Library window.
- 4. **Display Photo 1** to display the photo only.
- 5. **Display Mixed 1** to display the cellulite area superimposed on photo.
- 6. Name shows the name of the photo displayed in the Photo 1 frame.

- 7. **Date** shows the date at which the photo displayed in the **Photo 1** frame was captured.
- 8. Load Photo 2 to load a new photo and display it in the Photo 2 frame.
- 9. Show ROI 2 to show the ROI drawn in the Photo 2 frame photo.
- 10. Save ROI 2 to save the ROI under a specific name. When the "name' is inserted in the Save as window File Name edit box. The complete name of the file will be "Cell\_name\_oldname". Only photos with the prefix "Cell" can be uploaded into the TiVi95 Surface Library window.
- 11. **Display Photo 2** to display the photo only.
- 12. **Display Mixed 2** to display the cellulite area superimposed on photo.
- 13. Name shows the name of the photo displayed in the Photo 2 frame.
- 14. **Date** shows the date at which the photo displayed in the **Photo 2** frame was captured.
- 15. Clear All to clear both photos and reset the system.
- 16. Library to open the Library window.
- 17. **Sensitivity slider** to set the sensitivity of the cellulite threshold (default = 1).
- 18. Sensitivity Edit to set the sensitivity of the cellulite threshold (default = 1).
- 19. **Improvement Index** displays the improvement in cellulite appearance from photo1 to photo 2 (0 = no improvement, 1 = total improvement).
- 20. Close to close the application.
- 21. Surface Reflectivity to open the *TiVi95 Surface Reflectivity window*.
- 22. Manual to display the on-line *TiTi95 Skin Surface Analyzer* manual.
- 23. About TiVi95 TiVi95 about window.
- 24. **Demo Assistant** to open the Demo Assistant.

TiVi95trend							
— Display Ph	iotos						
		and the second s	-				
	Name:	Cell_A_ce-0001	Name:	Cell_A_ce-0002	Name:	Cell_A_ce-0003	
	Date:	26-Aug-2008 18:59:01	Date:	23-Oct-2008 14:48:01	Date:	13-Dec-2008 13:12:01	
	Imp Ind;	Reference	Imp Ind;	0.41	Imp Ind;	0.77	
	and the second se	2					
	Name:	Cell_A_ce-0004	Name:	Cell_A_ce-0005			
	Date:	15-Feb-2009 13:12:01	Date:	14-Jun-2009 09:26:01			
	Imp Ind;	0.93	Imp Ind;	0.94			
Load Photo	os 📧	Sensitivity	1	<ul> <li>Mixed</li> <li>Photo</li> </ul>	Trend	Export C	ose

## 4.2 Surface Analyzer TiVi95 Library window

- 1. Load Photos to upload new photos to the Library (only photos with the prefix "Cell" can be uploaded). Navigate to the folder that hosts the photos and select the files by first clicking on the first file, then pressing the **shift** button on the computer keyboard, while the last file is selected. Alternatively individual files can be selected while pressing the **Ctr** button on the computer key-board, while clicking on the actual file name.
- 2. **Sensitivity slider** to set the sensitivity of the cellulite threshold (default = 1).
- 3. Sensitivity Edit to set the sensitivity of the cellulite threshold (default = 1).
- 4. **Photo** to display the photo only.
- 5. Mixed to display the cellulite area superimposed on photos.
- 6. Trend to display the trend diagram showing the successive changes in Improvement Index.



- 7. Library to toggle back to the Library display.
- 8. Export to export the Improvement Index data to an MS Excel ® spreadsheet.
- 9. Close to close the Library window.
- 10. Below each photo the **Name, Date** and **Improvement Index** are displayed. The **Improvement Index** is displayed in red and refers to the cellulite improvement in relation to the first photo (also denoted **Reference Photo**).

### 4.3 Surface Reflectivity window

Using the *Surface Reflections* window the optical reflectance from a surface can be investigated by analyzing photos captured in cross- and co-polarization mode. The process starts with capturing two photos (one in cross- and one in co-polarization mode) of the same object.

1. Set the system to co-polarization mode by turning the Illuminator to a position where the back steering pint touches the magnet.

CR-polarization mode: two white dots next to each other.



CO-polarization mode: two white dots at 90 degrees apart.



- 2. Open the TiVi701Camera window by selecting Camera in the File pull-down menu.
- 3. Click the **Save Photo** button and insert the name "skin\_COCR2" to save the photos under the name with the prefix "skin\_COCR2".
- 4. Set **No of Photos** to 2.
- 5. Set **Delay** to 5.
- 6. Capture one co-polarized photo enhancing the surface reflections and then immediately click the **Pause** button to halt the photo capturing process.
- 7. Set the system to cross-polarization mode by turning the Illuminator to a position where the red steering pin touches the magnet
- 8. Without changing the position of the object in relation to the camera capture the crosspolarized photo enhancing sub-surface structures by clicking the **Continue**-button.

- 9. Two photos captured in the cross- and co-polarization mode respectively are now stored under the names *skin\_COCR2-0001* and *skin\_COCR2-0002* respectively.
- 10. In the following example these two files are pre-stored as examples in the folder *Skin\_COCR* in the *TiVi95demonstration folder*. In these two photos a cream has been topically applied to the skin. The surface reflectivity of skin areas with and without cream is to be compared.
- 11. Open the TiVi95 Skin Surface Analyzer window.

🛃 TiVi95 Skin Surface	e Analyzer 3	.1					- • ×
Surface Reflectivity	Manual	About	Demo Assistant				3
Wheels Bridge							
Photo 1					Photo 2		
Name:			Date:	Ī	Name:	Date:	
Load Photo	1		O Display Photo 1		Load Photo 2		🔿 Display Photo 2
Show ROI	1		Display Mixed 1		Show ROI 2		Oisplay Mixed 2
Save ROI	1				Save ROI 2		
L					L		
Clear All	1	Libra	Sensitivity		1 Improvement I	ndex:	Close
		LIDIO	···				

12. Open the **Surface Reflections** window by clicking **Surface Reflectivity** in the pulldown menu.

Jurface Reflections	
Co-Polarized Photo	Cross-Polarized Photo
Difference Photo	Surface Reflections:
Load CO Photo Filename:	Load CR Photo Filename:
Rel Surf Frac (%):	Threshold(%):

13. Click the **Load CO Photo** button and navigate to the *Skin\_COCR* folder located in the *TiVi95demostration* folder. Double click the *skin\_COCR-0001.jpg* file to upload this photo.

Surface Reflections	
Co-Polarized Photo	Cross-Polarized Photo
Difference Photo	Surface Reflections:
Load CO Photo Filename: skin_COCR-0001 jpg	Load CR Photo Filename:
Rel Surf Frac (%):	Threshold(%):

14. Click the **Load CR Photo** button and navigate to the *Skin\_COCR* folder located in the *TiVi95demostration* folder. Double click the *skin\_COCR-0002.jpg* file to upload this photo.

Surface Reflections	
	3
Co-Polarized Photo	Cross-Polarized Photo
Difference Photo	Total Int of diff photo
Load CO Photo Filename: skin_COCR-0001 jpg	Load CR Photo Filename: skin_COCR-0002.jpg
Rel Surf Frac (%): 36.31 Total Region 🔻	Threshold(%): 0 (]) Curves Close

- 15. In the Co-Polarized Photo frame, the *skin\_COCR-0001* photo is displayed.
- 16. In the Cross-Polarized Photo frame, the *skin\_COCR*-0002 photo is displayed.
- 17. In the **Difference Photo frame**, the difference between **the Co-polarized** and the **Cross-polarized** photo is displayed. Negative values are displayed in black colour.
- 18. In the **Total Int of diff photo** the intensity of the difference photo over the total intensity region is initially displayed. Areas with high surface reflection are displayed in brighter colours.
- 19. Select Red Region in the popup menu. The lower right frame now displays differences in the Red Region for pixels with values above the Threshold (with Threshold initially set to zero. In this particular case the relative number of pixels is displayed as Rel Surf Refl (%): 5.65 which is a measure of the reflectivity caused by the presence of the applied cream within the red colour region.

Surface Reflections	
	ĸ
Co-Polarized Photo	Cross-Polarized Photo
Difference Photo	Red plane difference
Load CO Photo Filename: skin_COCR-0001 jpg	Load CR Photo Filename: skin_COCR-0002.jpg
Rel Surf Frac (%): 5.65 Red Region 💌	Threshold(%):         Ourves         Close

- 20. Move the **Threshold** % slider until the associated **edit box** displays 10%. The **Rel Suraf Refl** (%) is now reduced to 3.25 reflecting the relative number of pixels with a value above 10% of max value in the **Red Region**.
- 21. The *popup* alternatives are as follows:

*Total Region*: The **Relative Reflectivity** above set **Threshold** for the entire bandwidth.

*Red Region*: The **Relative Reflectivity** above set **Threshold** for the red bandwidth region.

*Green Region*: The **Relative Reflectivity** above set **Threshold** for the green bandwidth region.

*Blue Region*: The **Relative Reflectivity** above set **Threshold** for the blue bandwidth region.

22. Click the **Curves** button to open the **Surface Reflections Diagram** window. This diagram displays the Relative number of pixels above threshold (%) as a function of Threshold (% of max). The four curves represent the surface reflectivity distributions within the different wavelength regions.



- 23. Click Export Data to save the data of the diagram in an *Excel* spreadsheet.
- 24. Click the Close button the close the Surface Reflections Diagram window.
- 25. Click the Close button the close the Surface Reflections window.