





Wound Analyzer TiVi103 User Manual

User Manual 1.2 Version 1.2 February 2019

PIONEERS IN TISSUE VIABILITY IMAGING

Dear Valued Customer!

Welcome to the WheelsBridge TiVi103 Wound Analyzer system intended for automatic analysis of the extent of tissues of different colours throughout a sequence of photos captured by the TiVi camera. The TiVi103 Wound Analyzer was designed for observer-independent analysis of changes in tissue colours of healing wounds and other tissue that may change colour for a variety of reasons.

The WheelsBridge TiVi103 Wound Analyzer utilizes a highly sensitive digital camera equipped with polarization filters making it possible to suppress surface reflections from the skin. 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 TiVi103 Wound Analyzer software the following are of particular interest:

- Automatic capturing of photos.
- Automatic tracking of tissues of specific colours.
- Up to 6 different colour space layers can be employed.
- Layers to be displayed are selected by the user.
- In addition to layer colours, the TiVi-value representing the microcirculation can be displayed.
- Curves representing areas of different colours are automatically generated and displayed.
- All data can be exported to ASCII-format spread sheets.

We are convinced that the TiVi103 Wound Analyzer will be a productive tool in the assessment and follow-up of wound healing and tissue repair processes in medical research.

Thank you for choosing the WheelsBridge TiVi103 Wound Analyzer.

WheelsBridge AB

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

WheelsBridge is a registered trade mark.

1. INTRODUCTION

The healing process of a wound is reflected in changes of the colour of the tissue within the wound area. Red colour generally represents hyperemic areas while black and yellow colours represent necrotic tissue and pus respectively. By following the dynamic changes of areas of such colours over time the effect of the healing process from a treatment procedure can be quantified and displayed.

The *TiVi103 Wound Analyzer* makes it possible to automatically track the extension of tissue of different colours over time as defined by setting of separate colour space parameters in high resolution photos captured in cross-polarization mode.

The intended use of the *TiVi103 Wound Analyzer* is to analyse wounds of different shapes and colour in experimental and research applications. It is not yet approved for the diagnosis and treatment of disease.

2. OPERATING PRINCIPLE

When the user clicks at a point in the photo the colour of the point clicked on is registered. The colour representation of that point is a triplet (Red, Green and Blue value) on a scale from 0 to 255. The triplet [0, 0, 0] represents black colour while [255,255,255] represents white colour. Red colour is represented by the triplet [255, 0 0], while green and blue colours are represented by the triplets [0, 255, 0], and [0, 0, 255] respectively. Any colour of a "true colour image" can be represented by a specific triplet of values.

Certain shades of adjacent colours can be represented as a volume composed of close triplets in the RGB colour space. When a specific point in the photo is pointed at by the mouse, the average value of 125 triplets around this colour is registered as the centre colour. The colour space around this centre colour is then set by the position of the **Expand Colour slider** which defines the colour space of the actual colour layer. This layer is displayed superimposed on the grayscale version of the photo in the **Image panel**. By changing the position of the **Expand Colour slider**, the area – and thus the number of triplets inside the defined colour space – changes to include more or less colours.

In the TiVi103 Wound Analyzer, the centre colour of a specific layer can be set in one of the following three ways.

- 1. Clicking at the actual point in the photo in the photo panel.
- 2. Setting the centre colours manually by use of the **Set Colour** window.
- 3. Uploading previously stored colour space parameters from file.

When a new colour space layer is created it is listed in the **Display Layer listbox**. Colour layers to be displayed in the **Image panel** photo are selected from this listbox.

To expand or shrink the colour space of a certain layer, the layer is first selected in the **Active Layer menu**. Moving the **Expand Colour slider** then changes the colour space of the selected layer. The changes are reflected in the photo in the **Image panel**.

A specific colour layer can be deleted by selecting the layer from the **Delete Layer menu**. Layers of higher order are then re-numerated to form a uniform sequence of layers.

The areas of the different layers can be dynamically displayed by clicking the **Automatic button**. After having scanned through and displayed all layers, the areas of different tissue colours in different photos in the sequence can be displayed as a curve in the **Curves window**.

3. GETTING STARTED

The basic features of the *TiVi103 Wound Analyzer* are probably best explained by way of an example. In the following example it is assumed that the photo *wound-0001.jpg* has been captured by a TiVi camera system and stored in the *TiVi103 demonstration* folder. This photo displays a wound with tissue components of different colours.

1. Open the *Wound Analyzer* toolbox from the **Toolbox** pull-down menu in the *TiVi700 Analyzer* window.

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2. Click the **First Photo** button and navigate to the *TiVi103 demonstration* folder and select the *wound-0001.jpg*.

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3. The opening page displays the photo in the **Photo-panel** and the corresponding TiViimage in the **Image panel**.

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4. Place the mouse pointer at a red area in the photo. Click the left mouse button to accept the colour of this point as the first layer target colour.

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Save Layers	Clear All	Show ROI Show Data Close

5. Move the **Expand Colour slider** to the right to expand the actual colour space so the red area fills out the inner area of the wound.

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Save Layers	Clear All	Show ROI Show Data Close

6. Click somewhere at the yellow colour area in the photo in the **Photo**-panel to select this colour as the second target colour. The main window should now look like:

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7. Drag the **Grayscale slider** to the left to reduce the intensity of the background tissue to make the yellow areas more visible.

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8. Move the **Expand Colour slider** to the left to reduce the volume of the yellow colour space.

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9. Two tissue areas inside the wound have now been defined with their specific colour spaces around the centre target colours. Click *Layer1* and *Layer2* while simultaneously pressing the **Ctrl-button** on the computer key–board to display tissues of colours inside the two colour spaces selected.

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10. Click the **Show Data** button to display the **TiVi103 Data** window. This window shows the centre and end boundary colours of the two colour spaces selected. The corresponding RGB values are displayed next to the colour indicators. Click the **Close** button to close the **TiVi103 Data** window.



11. To insert a new layer based on numerical setting of the centre colour click the **Set Colours button** to open the **TiVi103 SetColour** window.

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4	Green Colour	27
4	Blue Colour	27 ОК

12. Drag the **Green** and **Blue Colour sliders** to display a value of 60 corresponding to a centre colour of brown.

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	Green Colour		60	
	Blue Colour		60	ок

13. Click the **OK** button to accept these settings and return to the main window.



14. Insert the value "0.2" in the **Expand Colour slider** edit-box to expand the colour space of layer 3.

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15. Keep the keyboard **Ctrl-button** pressed while selecting *Layer1*, *Layer2*, and *Layer 3* by clicking on the text in the **Display Layer listbox**. All three layers are now displayed in the **Image panel** photo.

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Save Layers	Clear All	Show ROI Show Data Close

16. To reduce the extension of the colour space associated with *layer 1*, select *Layer1* from the **Active Layer** menu. Move the **Expand Colour slider** until the edit box reads 0.13.

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Save Layers	Clear All	Show ROI Show Data Close

17. To remove *Layer 2*, select *Layer 2* from the **Delete Layer** menu. The former *Layer 3* now becomes the new *Layer 2*.

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Last Photo weund-0001 jpg	Last Photo Step 1 Clear All	Display Layer Active Layer	Delete Layer Layer 1 • Expand Colour Grayscale 0.29 Close

- 18. To save the colour space parameters for the remaining two layers click **Save Layers** and save the parameters under the name "MyLayers" in a suitable folder.
- 19. Click Clear All to reset the system and prepare it for analysis of new photos.
- 20. Click the First Photo button and select *Psor-0001* from the *TiVi103demonstration* folder.



21. Click the **Last Photo button** and select *Psor-0007* from the same folder. The photo sequence *Psor-0001* to *Psor-0007* are now set for automatic analysis.



22. To use the colour space parameters saved for *wound-0001*, click **Load Layers** and navigate to the folder in which the "MyLayers" file was saved. Double click the file to upload the parameters.



23. Select Layer 2 by checking this item in the Display Layer listbox.

- 24. Remove both of these layers by successively clicking *Layer 2* and *Layer 1* in the **Delete Layer menu**. All layers are now cleared.
- 25. To display inflammatory areas click on a dark read area in the left photo.



26. To display also scaling tissue click on a light yellow point in the photo. This will now form the basis for the second layer.



27. Move the **Grayscale slider** to its leftmost position and select both layers in the **Display** Layer listbox.



28. Click the **Automatic button** to scan through the sequence of photos and layers selected. Click the **Show Curves button** to display the extension of inflammatory areas (red) and scaling tissue (yellow) throughout the sequence of photos.



29. Drag the **Background Colour slider** to its leftmost position and select *Zero-based* from the **Select Y_axis menu**.



- 30. This diagram shows how the extension of areas of inflammatory tissue is reduced while the extension of scaling tissue areas is increased
- 31. This completes the **GETTING STARTED** section.

4. DETAILED DESCRIPTION

The TiVi103 Wound Analyzer main window

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Last Photo wound-0001.jpg Load Layers Save Layers V0-25 V1-25	Last Photo Step 1 Clear All	Display Layer Active Layer Delete Layer Layer 1 Set Colours Expand Colour 0.16 Show ROI Show ROI Close Close

Photo Panel

- 1. Number of Layers display the number of active layers.
- 2. Photo size displays the size (in pixels) of the photo .
- **3.** Clicking in the photo placing the mouse pointer somewhere in the photo and clicking with the left mouse button at this point makes the system register the colour at the point and and use this colour as the centre colour of the colour space displayed in the grayscale photo in the Image panel.
- 4. Drawing a ROI in the photo use this option to draw a ROI in the photo. This ROI is used when the Show ROI button is clicked.
- 5. **The vertical bar** to display the relative number of the photo displayed.
- 6. Time & Date displays the time and date at which the displayed photo was captured

Select Image Panel

- 1. **Display photo** displays either the TiVi-image or a gray-scale photo with the selected layers superimposed.
- 2. Colour Scale and Statistics displays TiVi-image statistics and the colours scale in use (TiVi-mode) or the colour layers selected and the associated area (in pixels) covered by colours within the colour space of the actual layer.

Select Photo Panel

- 1. Show First Photo button to display the first photo in a sequence.
- 2. Show Last Photo button to display the last photo in a sequence.
- 3. First Photo button to select the first photo to be displayed from file.
- 4. Last Photo button to select the last photo to be displayed from file.
- Step edit box to select the step in the photo sequence to be displayed (default value = 1).
- 6. Load Layers button to load a saved set of colour space parameters from file.
- 7. Save Layers button to save tha actual colour space parameters to file .
- **8.** Clear All button to reset the main window.
- **9.** Actual Photo edit box displays the name of the actual photo. To select a specific photo in a sequence, insert its name and click the Enter button on the keyboard.
- 10. First Photo edit box displays the name of the first photo in the sequence.
- 11. Last Photo edit box displays the name of the last photo in the sequence.
- **12.** Coordinates displays the actual coordinates of the mouse pointer when this is moved over the photo. Also displays the coordinates of the ROI drawn.

Step Through Panel

- 1. **Reverese/Forward button** to set to reverse or forward mode when the photos are displayed using the **Manual** button.
- 2. Manual button to move to the next photo in the sequenec to be displayed.

- **3.** Automatic button to scan through the photos with selecte layers displayed. This button is also to be clicked to update the colour layers before the **Show Curves** button can be clicked.
- 4. Pause/Continue to pause and continue automatic display of photos.
- 5. Comments an editable wordpad that is saved as meta-data with the actual photo.
- 6. Color Span the set the colour span of the TiVi-images displayed.

Display Panel

- 1. **Display Layer listbox** select colour layers from this list to be displayed superimposed on the grayscale photo. Several layers can be selected to be displayed simultaneously by holding down the **Ctr-button** on the computer keyboard while clicking on the various items displayed.
- 2. Active Layer pull-down menu to select the actice colour layer. The extent of the colour space associated with the active layer can be changed by dragging the Expand Colour slider.
- 3. Delete Layer pull-down menu to select a layer to be deleted from the Display Layer listbox.
- 4. **Expand Colour slider** to set the extension of the colour space of the active layer.
- 5. Expand Colour edit box to set the extension of the colour space of the active layer.
- 6. **Grayscale slider** to set the intensity of the background grayscale photo.
- 7. Grayscale edit box to set the intensity of the background grayscale photo.
- 8. Show ROI button to display the section of the photo defined by the ROI drawn.
- 9. Set Colours button to open a window in which the colour layer central colour can be set manually.
- 10. Show Curves button to open a window displaying the areas of the colour layers selected by the **Display Layer listbox**. Accessible only after the **Automatic button** has been clicked.
- 11. Show Data button to open a window displaying the parameters of the colour layers.
- 12. **Close button** to close the main window.

Pull-down menus

- 1. TiVi-Pre-Processor to start the TiVi Pre-Processor for alignment of photos.
- 2. Manual to open the on-line *TiVi103 Wound Analyzer* manual.
- **3.** About about the *TiVi103 Wound Analyzer* toolbox.

Set Colours Window

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- 1. Red, Green & Blue Colour sliders to manually set the centre colour of a new colour layer.
- 2. Red, Green & Blue Colour edit boxes to manually set the centre colour of a new colour layer.
- **3. Image** displays the colour set.
- 4. Close to close the *TiVi103 Set Colours window*.

Show Data Window

Min(RGB)	Average(RGB)	Max(RGB)
198 82 76	211 95 88	224 107 101
115 115 115	128 128 128	140 140 140
0 0 0	000	000
000	000	000
000	000	000
0 0 0	000	000
		Close
1	98 82 76 15 115 115 0 0 0 0	98 82 76 211 95 88 15 115 115 128 128 128 00 0 0 0 00 0 0 0 00 0 0 0

Displays the centre (Average) colour, Min colour and Max colour of the colour spaces of the individual colour layers.

Show Curves Window



- 1. **Curves diagram –** displays the areas (in pixels) of colours within the colour spaces of the different layers dispayed (*Areas* versus *Image Number*).
- 2. **Display** shows the centre colours of the layers displayed. Each layer can be excluded or included by checking the chack-boxes in front of the colour indicators.
- 3. Select Y-axis menu to select the setting of the diagram y-axis.
- 4. **Export Data** to export data to an *Excel* spread-sheet.
- 5. **Background Colour slider and edit box** to set the intensity of the diagram background.
- 6. Close to close the *TiVi103 Curves window*.