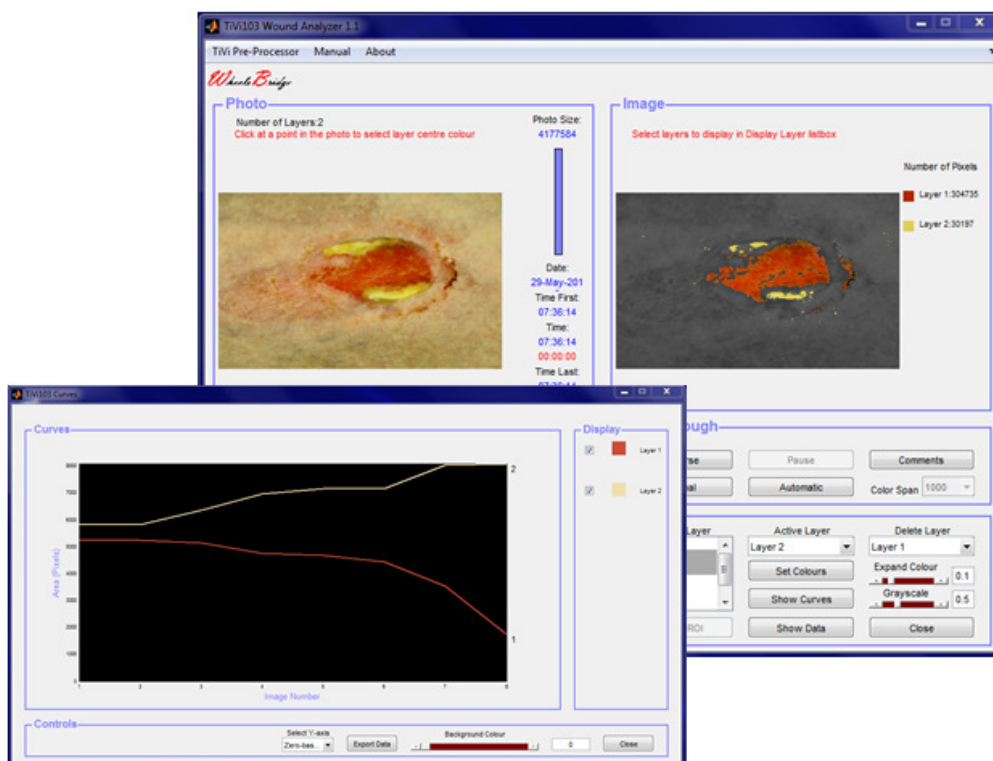




Wheel Bridge



Wound Analyzer TiVi103 User Manual

User Manual 1.2
Version 1.2
February 2019

PIONEERS IN TISSUE VIABILITY IMAGING

TiVi103 Wound Analyzer

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

TiVi103 Wound Analyzer

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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.

TiVi103 Wound Analyzer

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**.

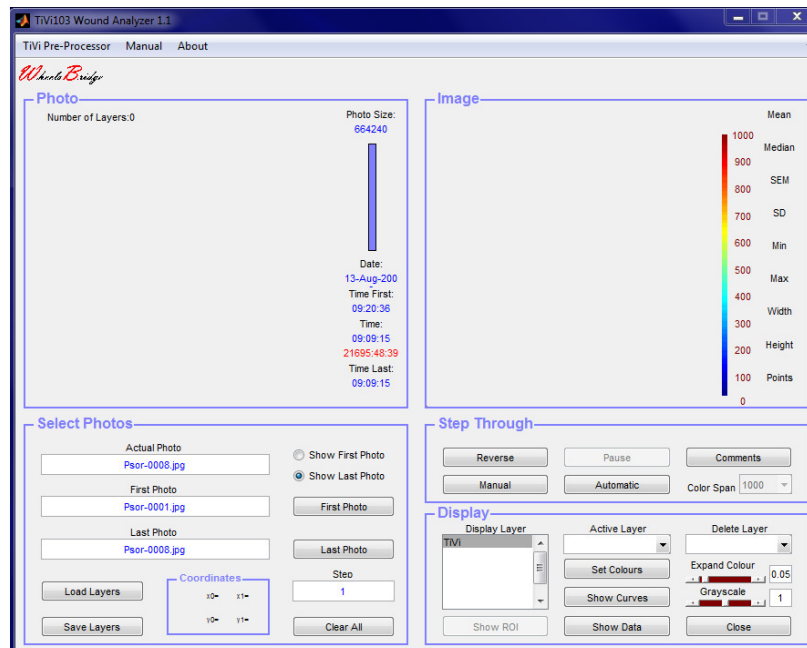
A specific colour layer can be deleted by selecting the layer from the **Delete Layer menu**. Layers of higher order are then re-numerated to form a uniform sequence of layers.

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

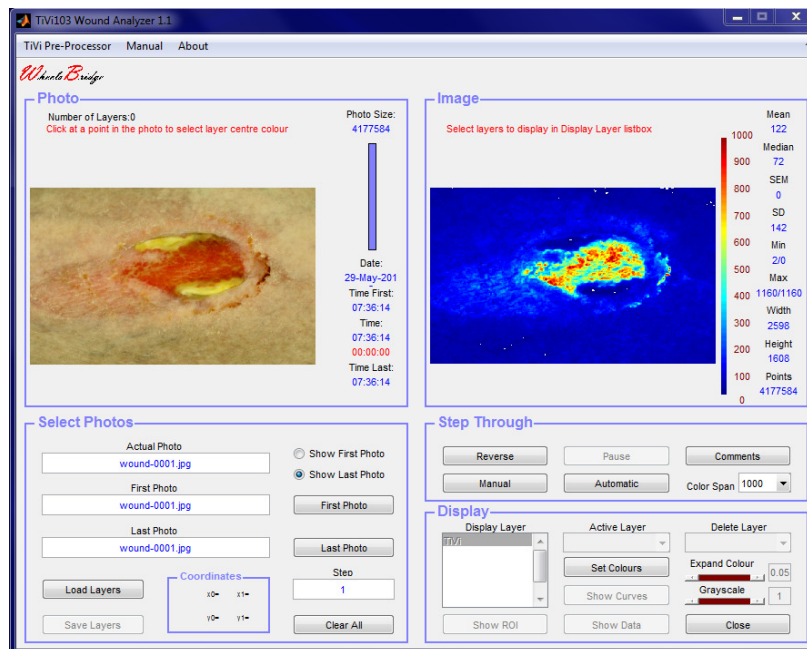
The basic features of the *TiVi103 Wound Analyzer* are probably best explained by way of an example. In the following example it is assumed that the photo *wound-0001.jpg* has been captured by a TiVi camera system and stored in the *TiVi103 demonstration* folder. This photo displays a wound with tissue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

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

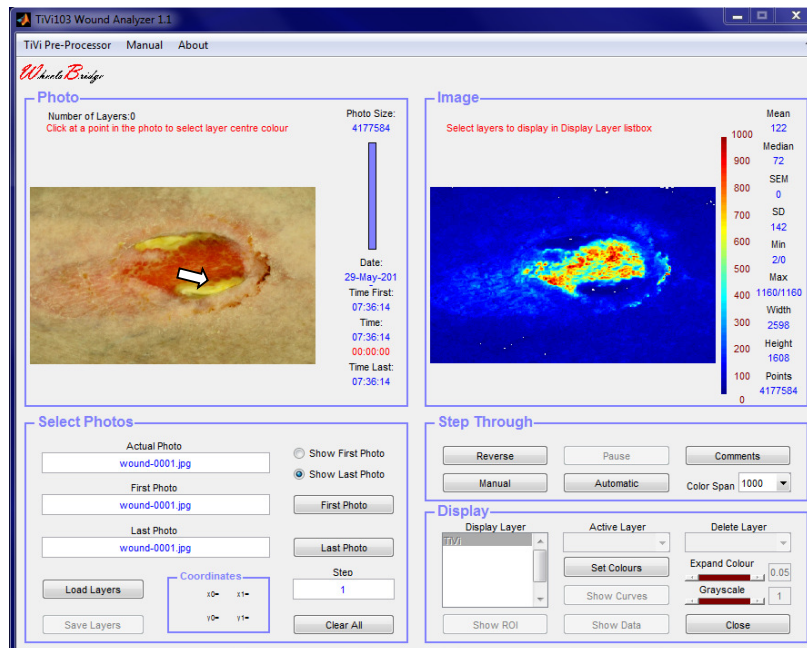


2. Click the **First Photo** button and navigate to the *TiVi103 demonstration* folder and select the *wound-0001.jpg*.

TiVi103 Wound Analyzer

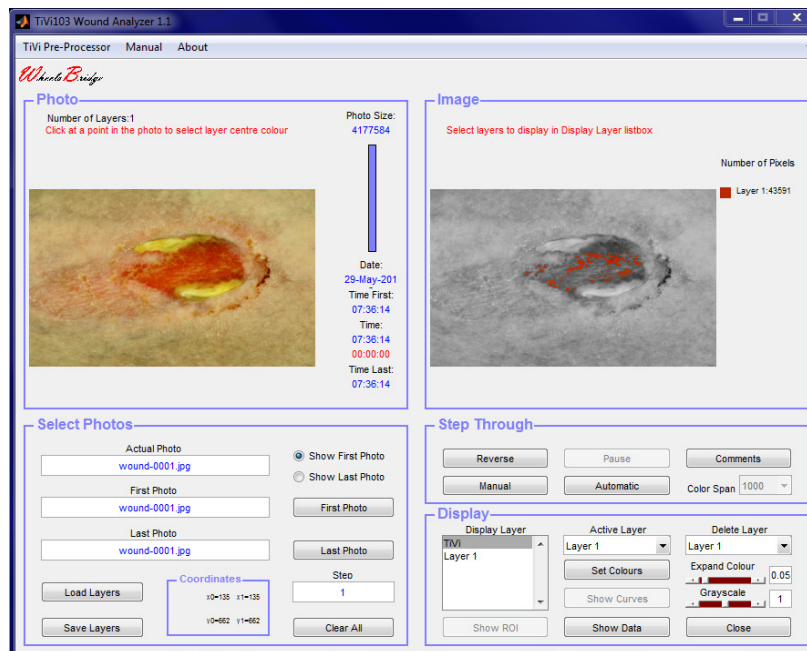


3. The opening page displays the photo in the **Photo-panel** and the corresponding TiVi-image in the **Image panel**.

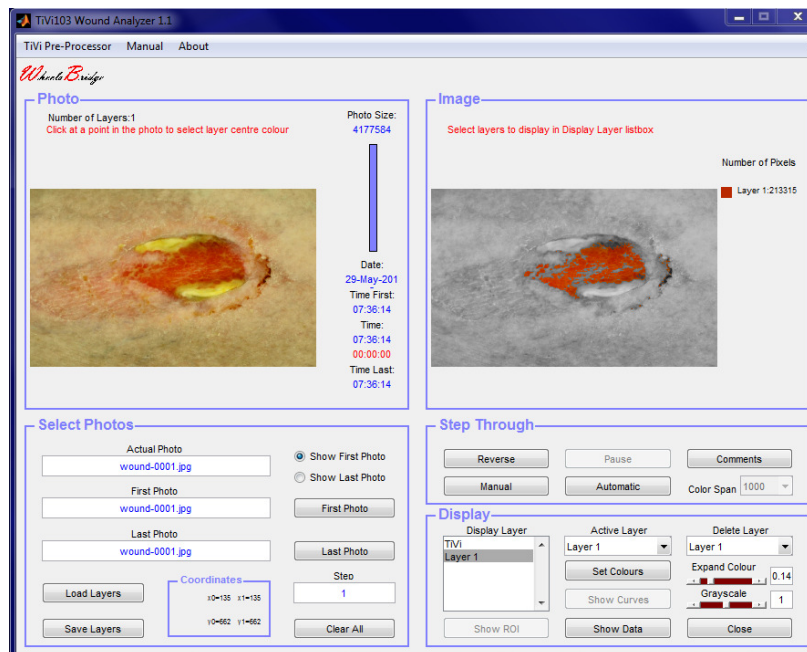


4. Place the mouse pointer at a red area in the photo. Click the left mouse button to accept the colour of this point as the first layer target colour.

TiVi103 Wound Analyzer

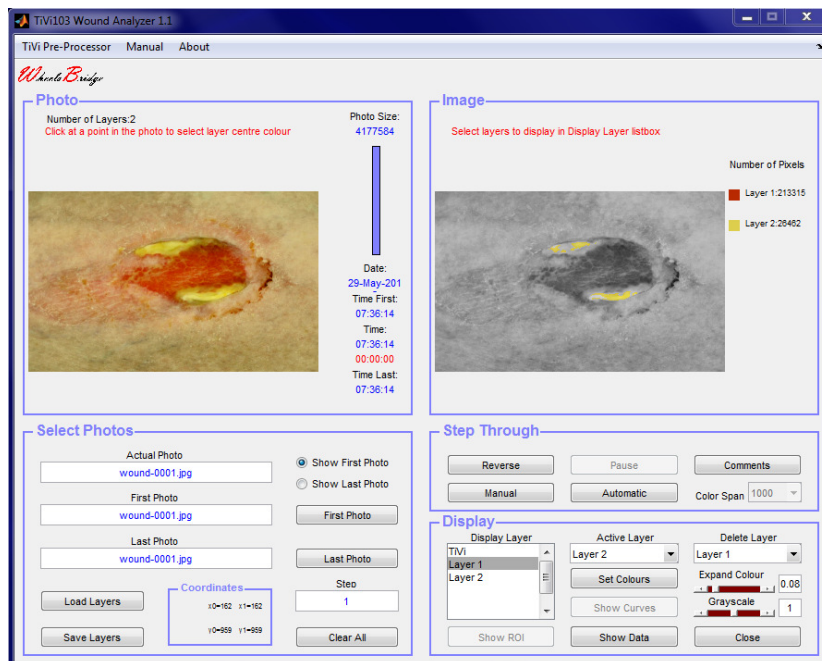


5. Move the **Expand Colour** slider to the right to expand the actual colour space so the red area fills out the inner area of the wound.

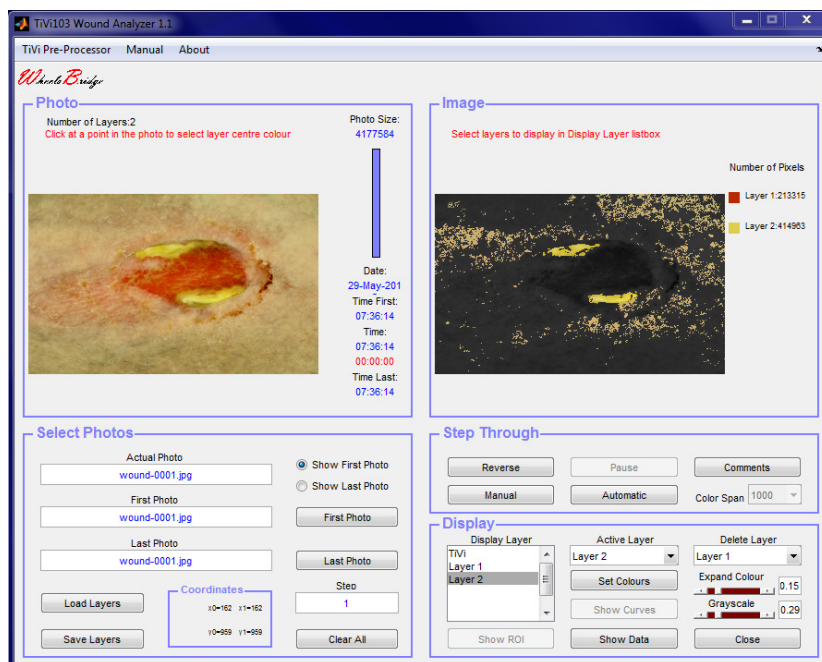


6. Click somewhere at the yellow colour area in the photo in the **Photo**-panel to select this colour as the second target colour. The main window should now look like:

TiVi103 Wound Analyzer

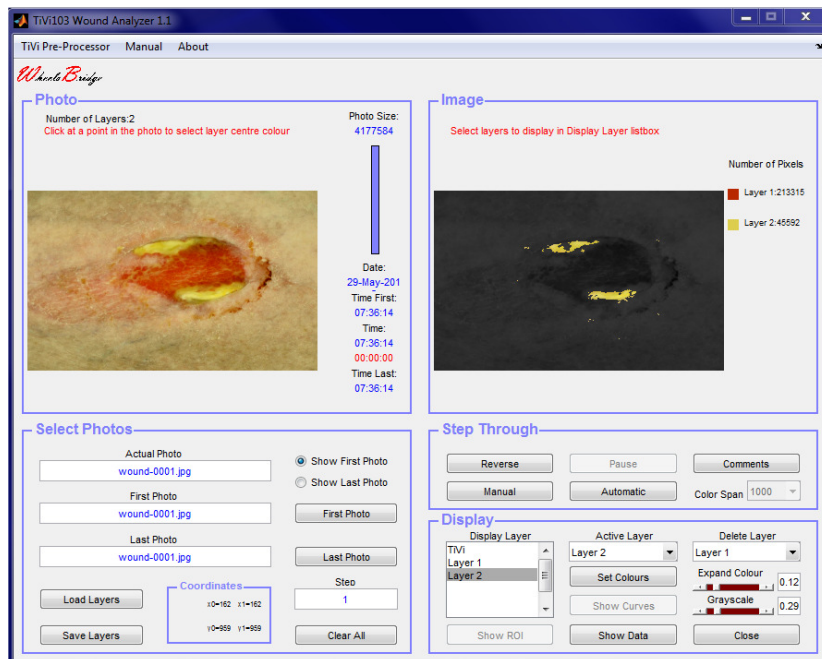


7. Drag the **Grayscale slider** to the left to reduce the intensity of the background tissue to make the yellow areas more visible.

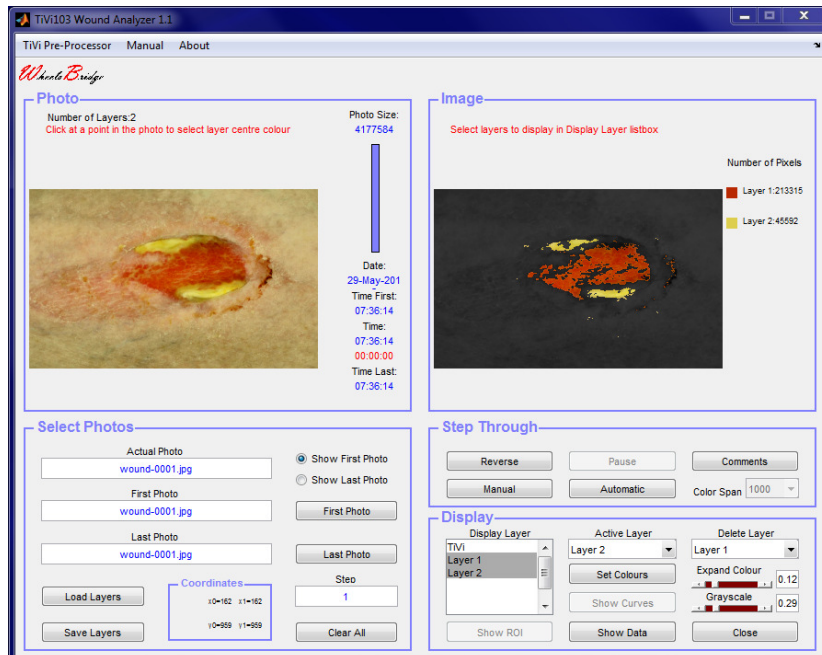


8. Move the **Expand Colour slider** to the left to reduce the volume of the yellow colour space.

TiVi103 Wound Analyzer

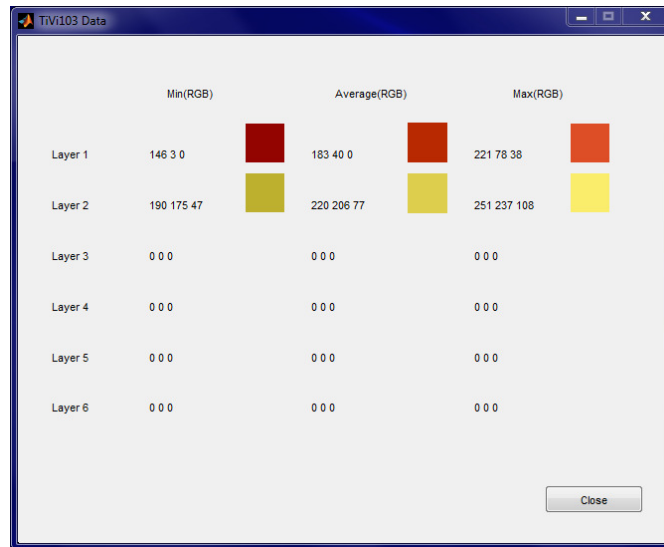


9. Two tissue areas inside the wound have now been defined with their specific colour spaces around the centre target colours. Click *Layer1* and *Layer2* while simultaneously pressing the **Ctrl-button** on the computer key-board to display tissues of colours inside the two colour spaces selected.

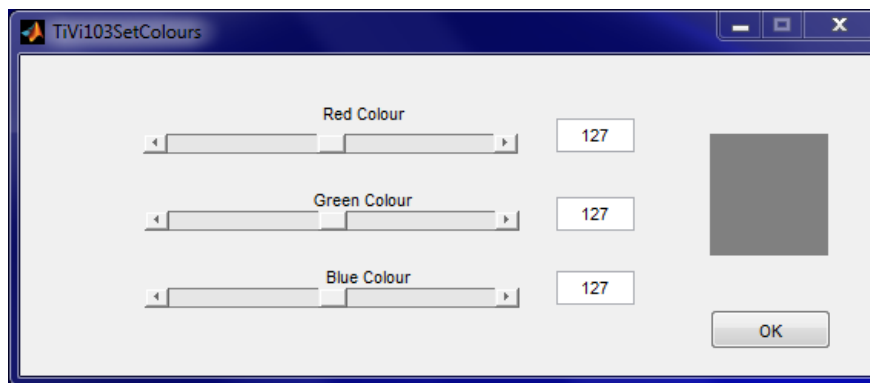


10. Click the **Show Data** button to display the **TiVi103 Data** window. This window shows the centre and end boundary colours of the two colour spaces selected. The corresponding RGB values are displayed next to the colour indicators. Click the **Close** button to close the **TiVi103 Data** window.

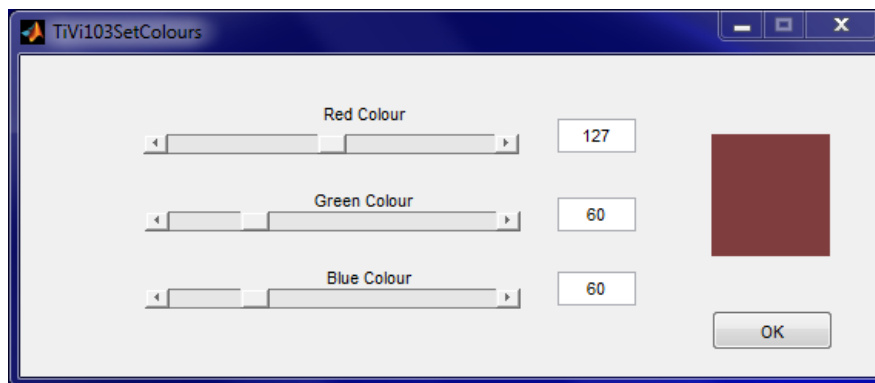
TiVi103 Wound Analyzer



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.



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

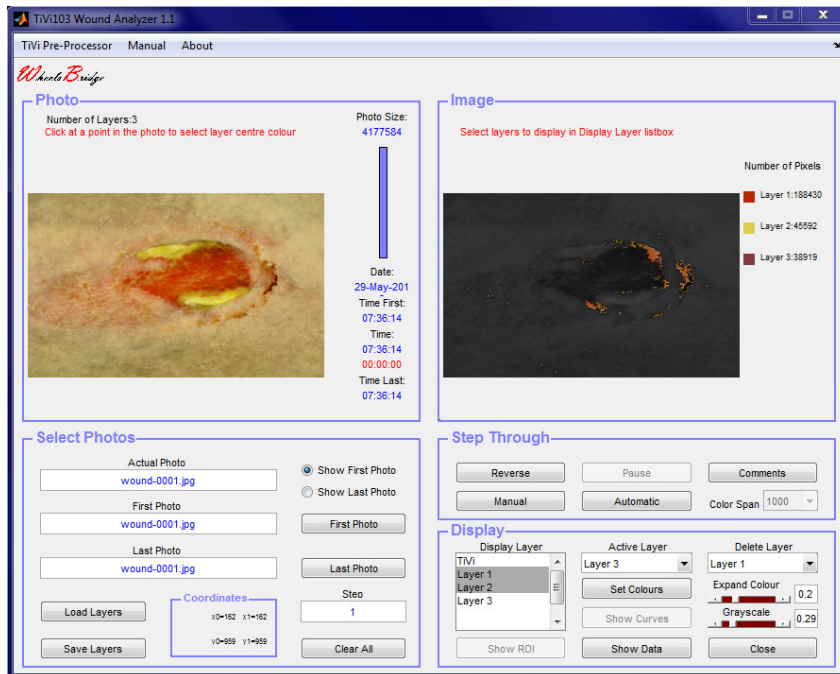


TiVi103 Wound Analyzer

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

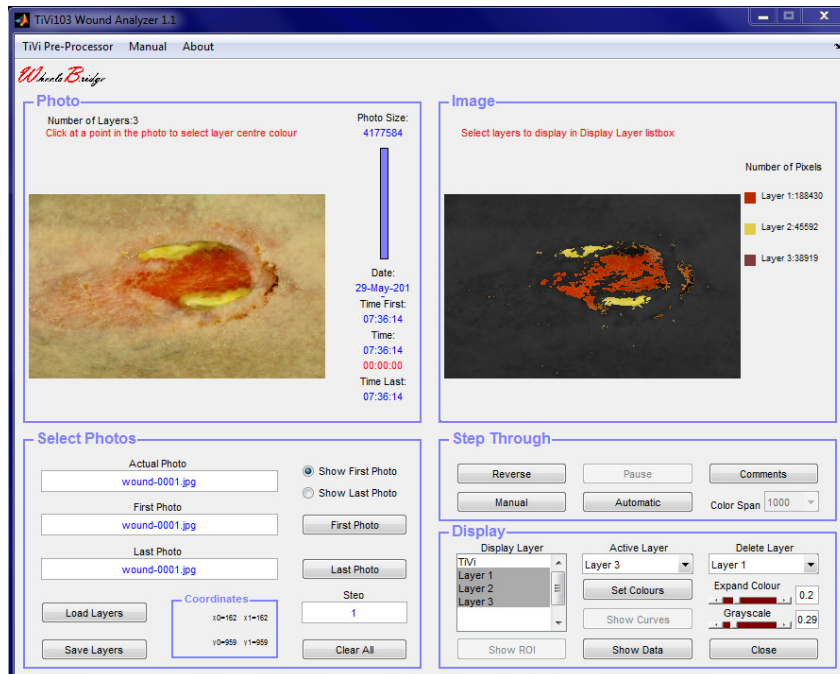


14. Insert the value “0.2” in the **Expand Colour** slider edit-box to expand the colour space of layer 3.

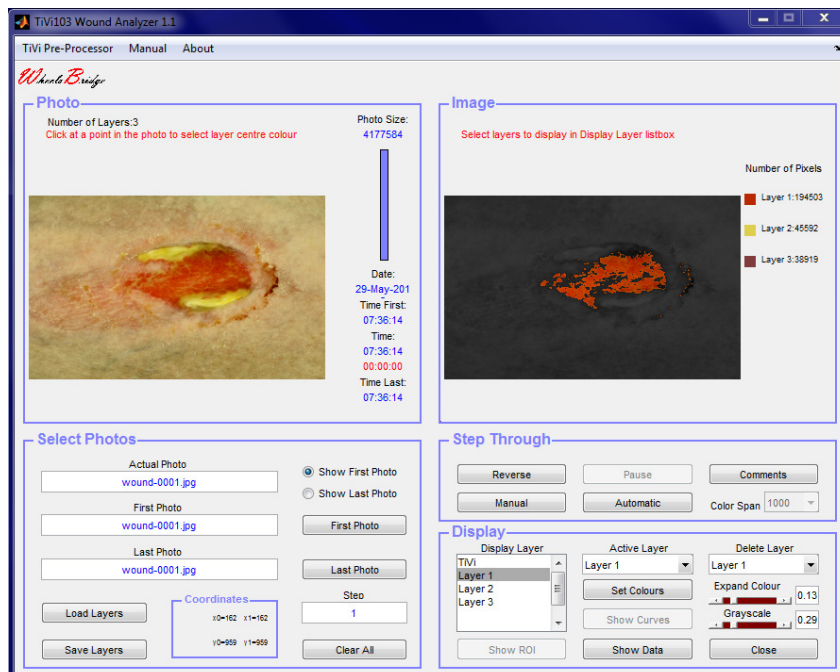


15. Keep the keyboard **Ctrl**-button pressed while selecting *Layer1*, *Layer2*, and *Layer 3* by clicking on the text in the **Display Layer** listbox. All three layers are now displayed in the **Image** panel photo.

TiVi103 Wound Analyzer

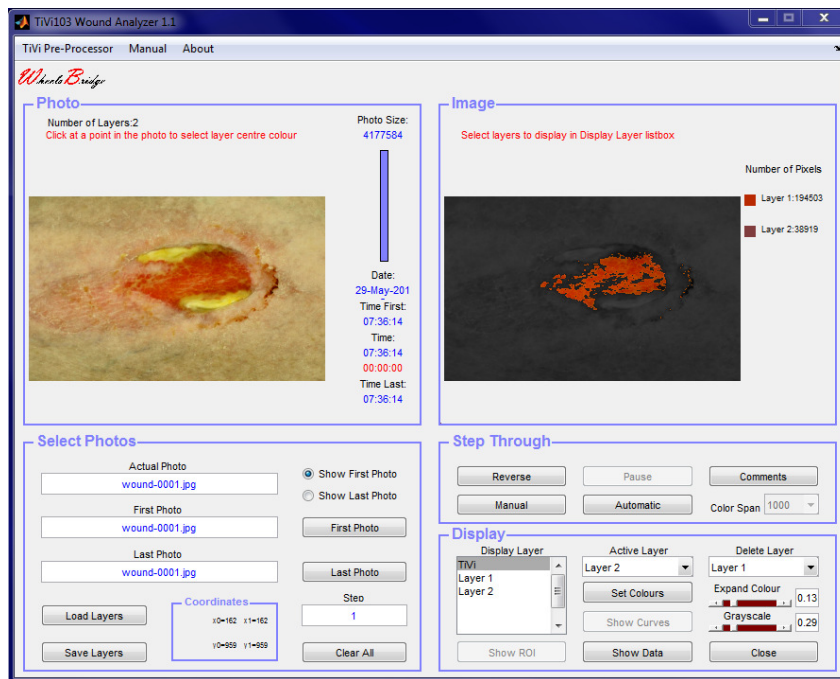


16. To reduce the extension of the colour space associated with *layer 1*, select *Layer 1* from the **Active Layer** menu. Move the **Expand Colour** slider until the edit box reads 0.13.

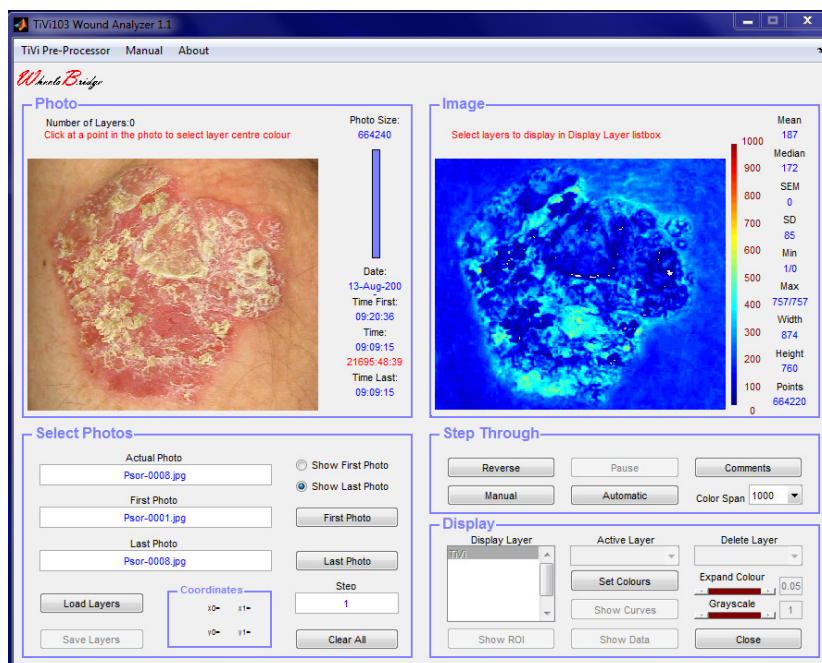


17. To remove *Layer 2*, select *Layer 2* from the **Delete Layer** menu. The former *Layer 3* now becomes the new *Layer 2*.

TiVi103 Wound Analyzer

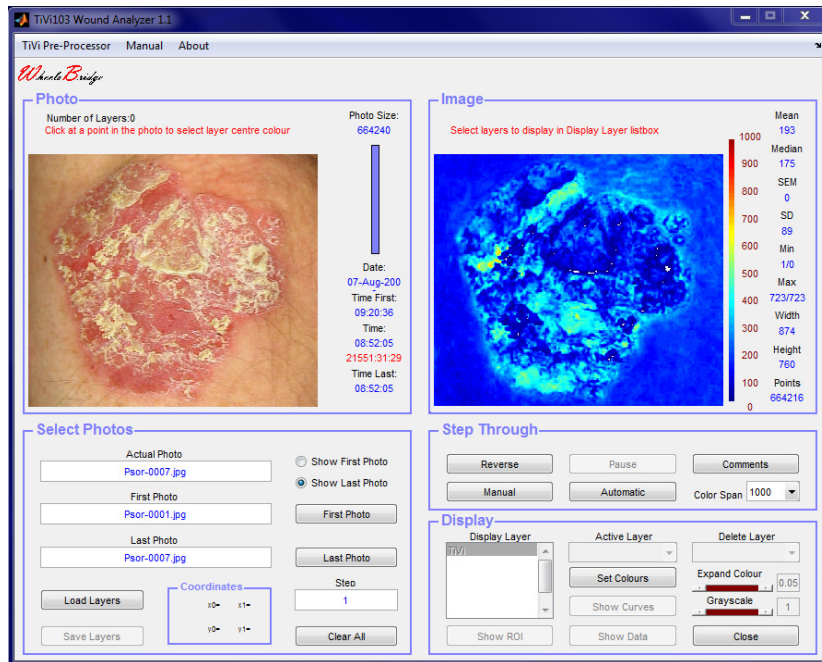


18. To save the colour space parameters for the remaining two layers click **Save Layers** and save the parameters under the name “MyLayers” in a suitable folder.
19. Click **Clear All** to reset the system and prepare it for analysis of new photos.
20. Click the First Photo button and select *Psor-0001*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

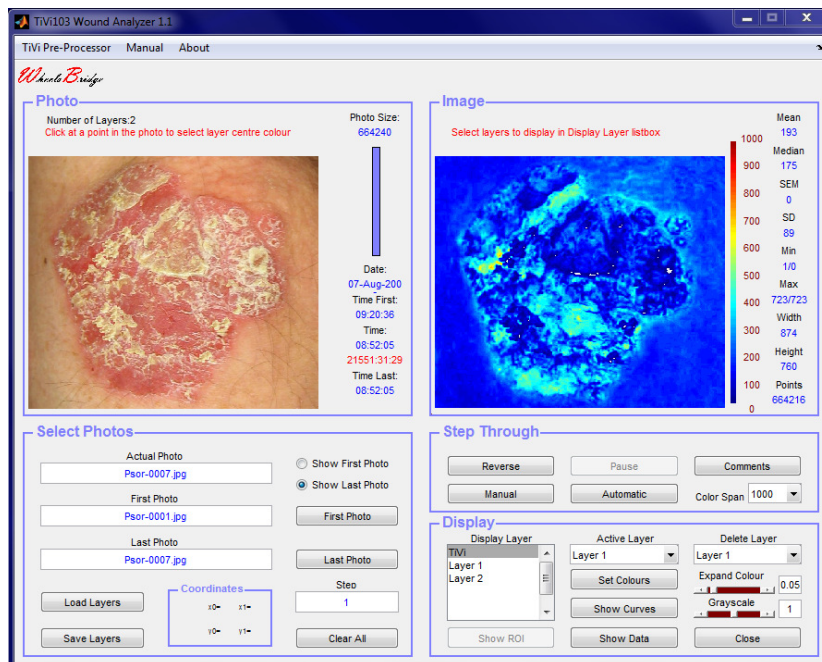


TiVi103 Wound Analyzer

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.



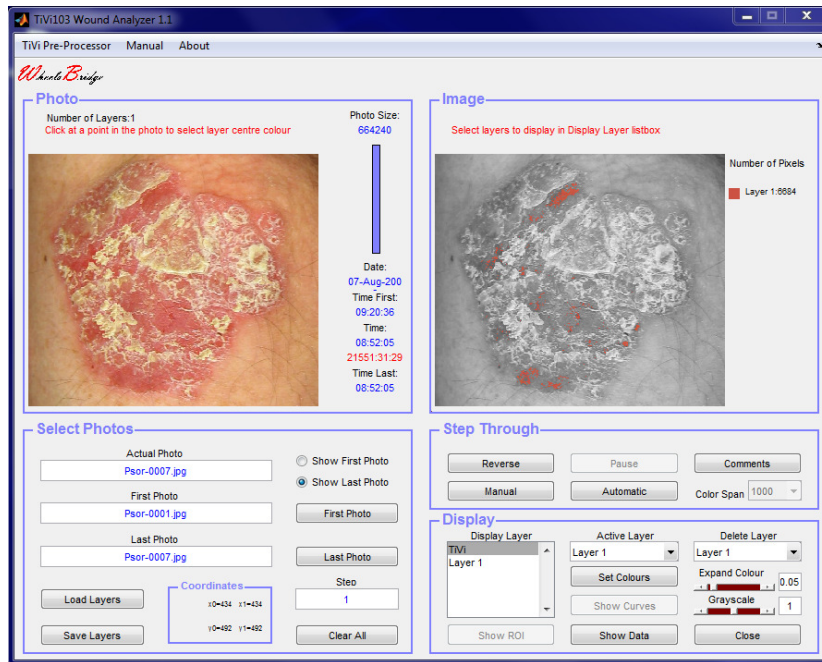
22. To use the colour space parameters saved for *wound-0001*, click **Load Layers** and navigate to the folder in which the “MyLayers” file was saved. Double click the file to upload the parameters.



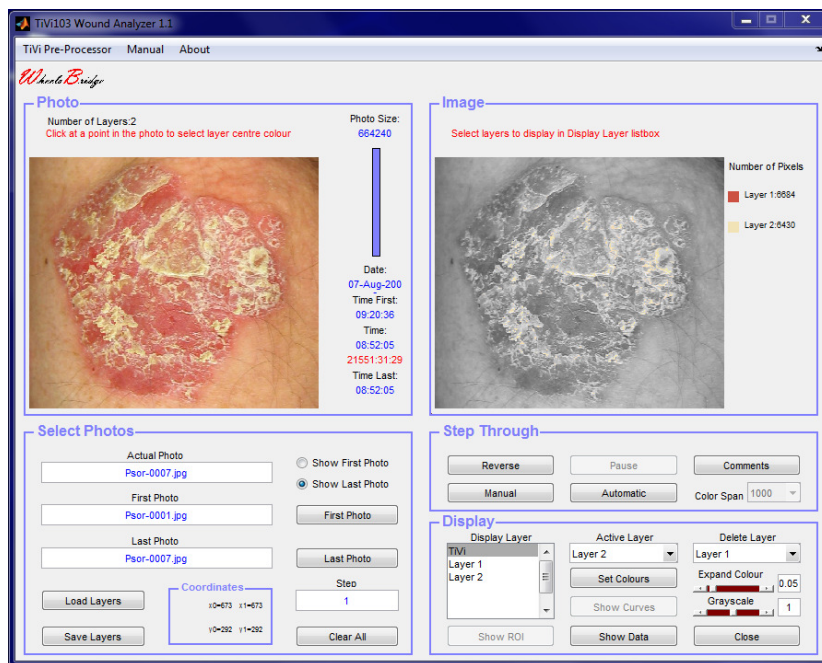
23. Select *Layer 2* by checking this item in the **Display Layer** listbox.

TiVi103 Wound Analyzer

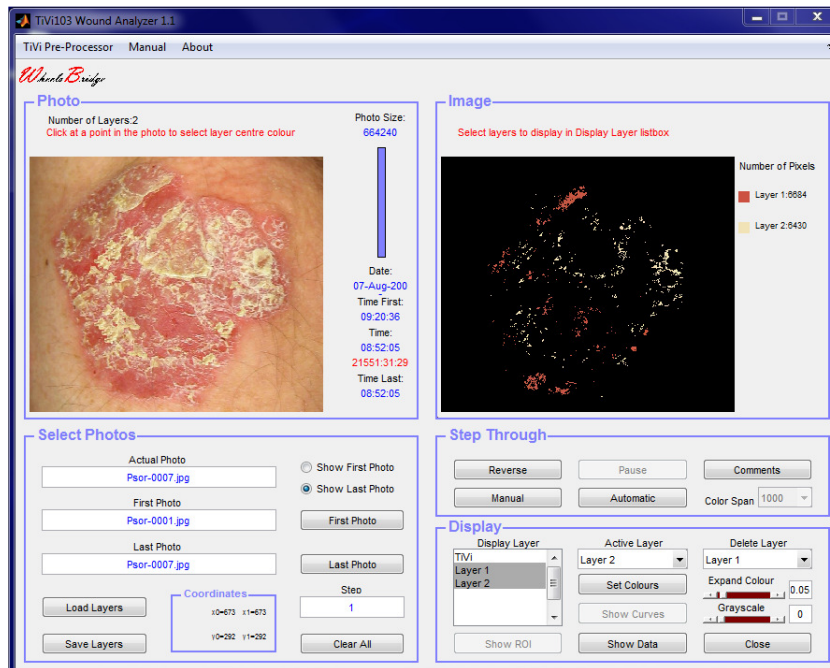
24. Remove both of these layers by successively clicking *Layer 2* and *Layer 1* in the **Delete Layer** menu. All layers are now cleared.
25. To display inflammatory areas click on a dark red area in the left photo.



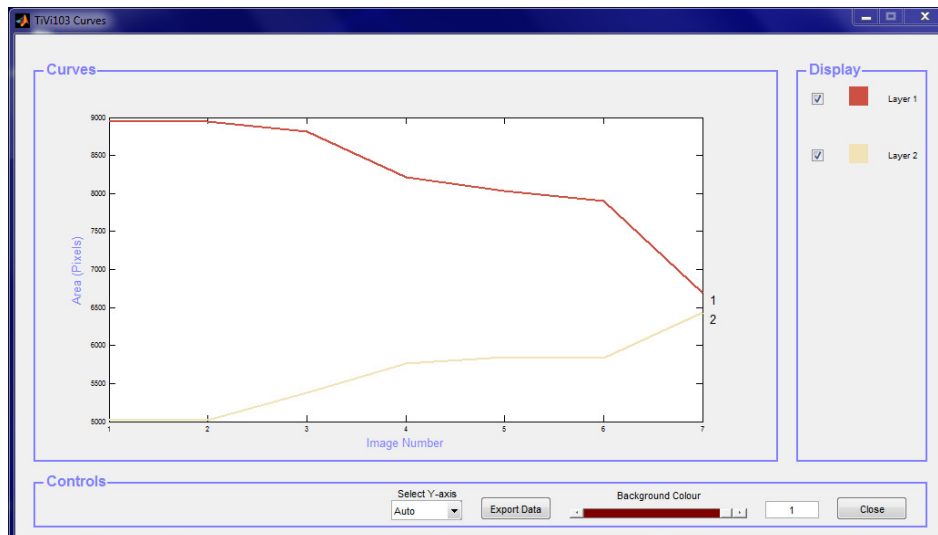
26. To display also scaling tissue click on a light yellow point in the photo. This will now form the basis for the second layer.



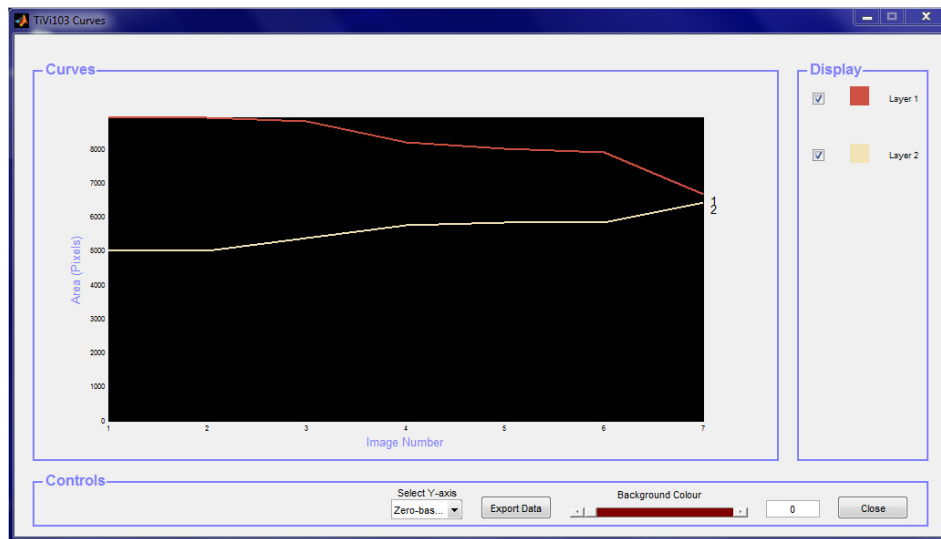
27. Move the **Grayscale slider** to its leftmost position and select both layers in the **Display Layer** listbox.



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

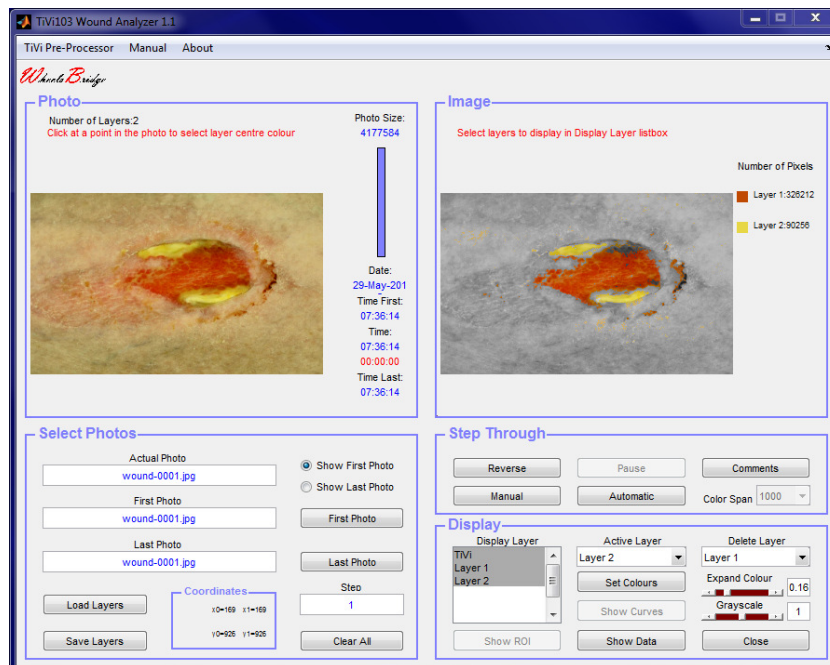


Photo Panel

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 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.
5. **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 the 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. **Reverse/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 sequence to be displayed.

3. **Automatic button** – to scan through the photos with selected 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** – to set the colour span of the TiVi-images displayed.

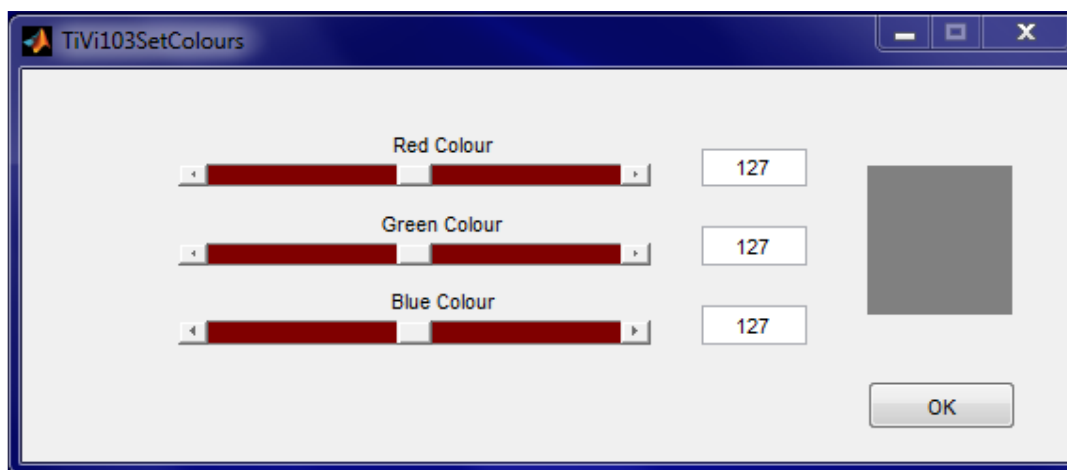
Display Panel

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 **Ctrl-button** on the computer keyboard while clicking on the various items displayed.
2. **Active Layer pull-down menu** – to select the active 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

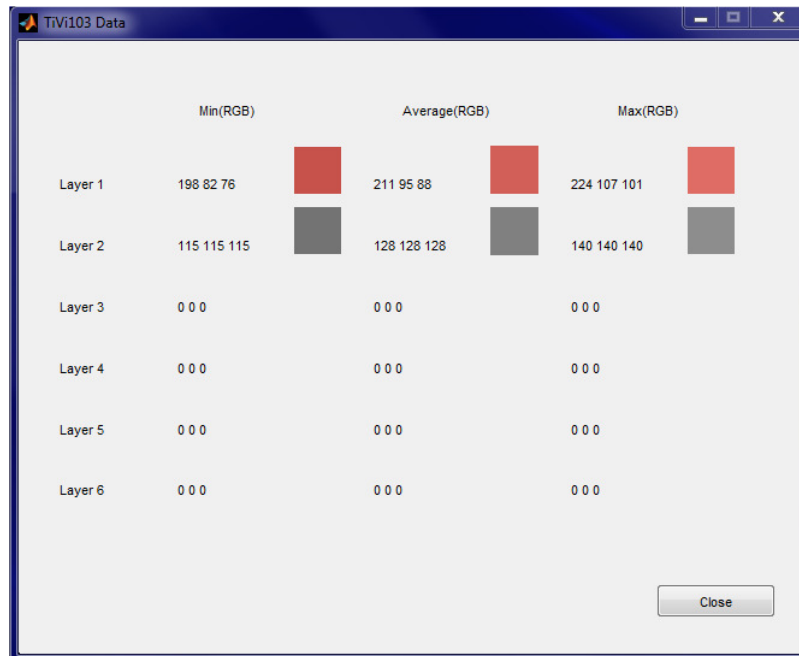
1. **TiVi-Pre-Processor** – to start the *TiVi Pre-Processor* for alignment of photos.
2. **Manual** – to open the on-line *TiVi103 Wound Analyzer* manual.
3. **About** – about the *TiVi103 Wound Analyzer* toolbox.

Set Colours Window



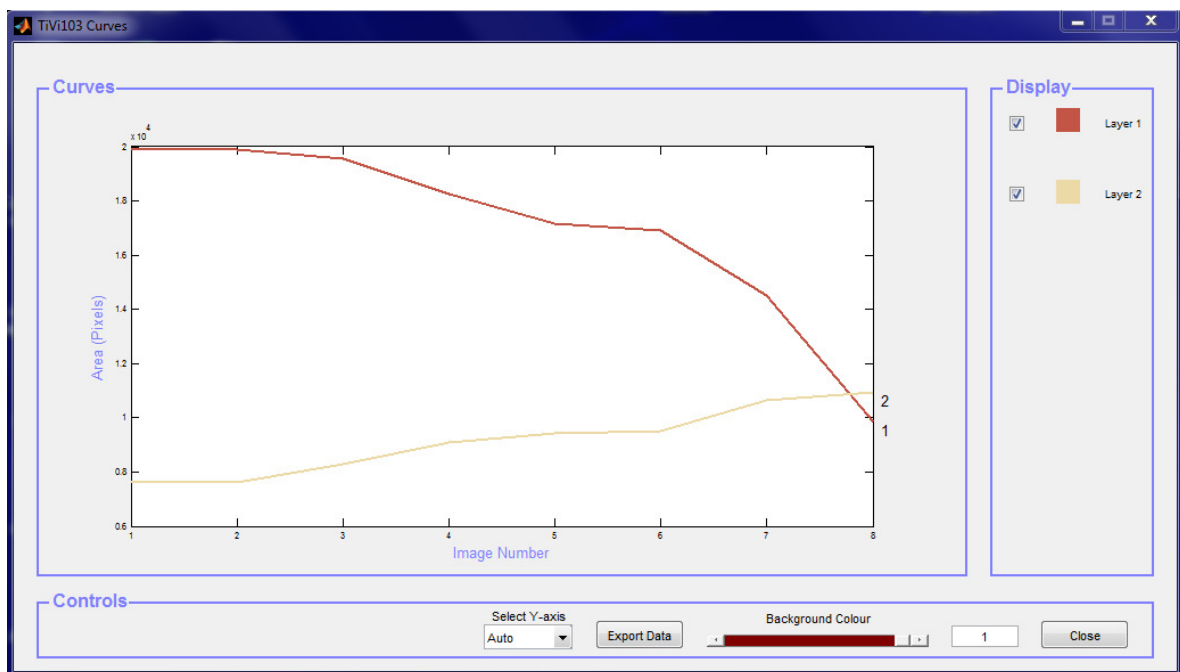
1. **Red, Green & Blue Colour sliders** – to manually set the centre colour of a new colour layer.
2. **Red, Green & Blue Colour edit boxes** – to manually set the centre colour of a new colour layer.
3. **Image** – displays the colour set.
4. **Close** – to close the *TiVi103 Set Colours window*.

Show Data Window



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 displayed (*Areas* versus *Image Number*).
2. **Display** – shows the centre colours of the layers displayed. Each layer can be excluded or included by checking the check-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*.