

Capillary Velocity

CapiScope 4.37.0.0 - jilly-20170517_150615.dcs

File Edit View Settings Controls Tools Window Help

Record Video Image to Name

jilly-20170517_150615.dcs

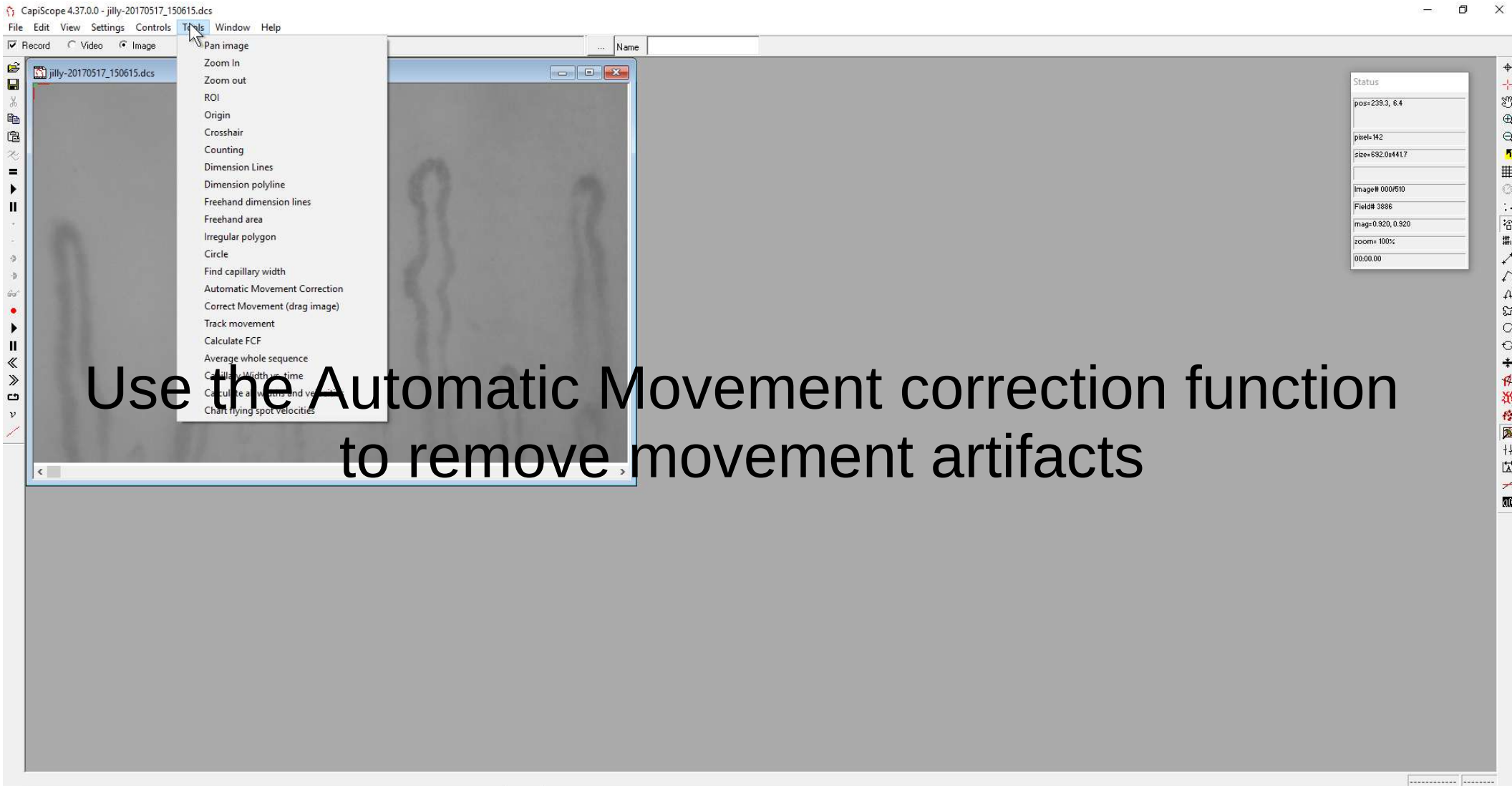
Status

pos=	0.0, 0.0
pixels	145
size=	632.0x441.7
image#	000/510
Field#	3886
mag=	0.920, 0.920
zoom=	100%
	00:00:00

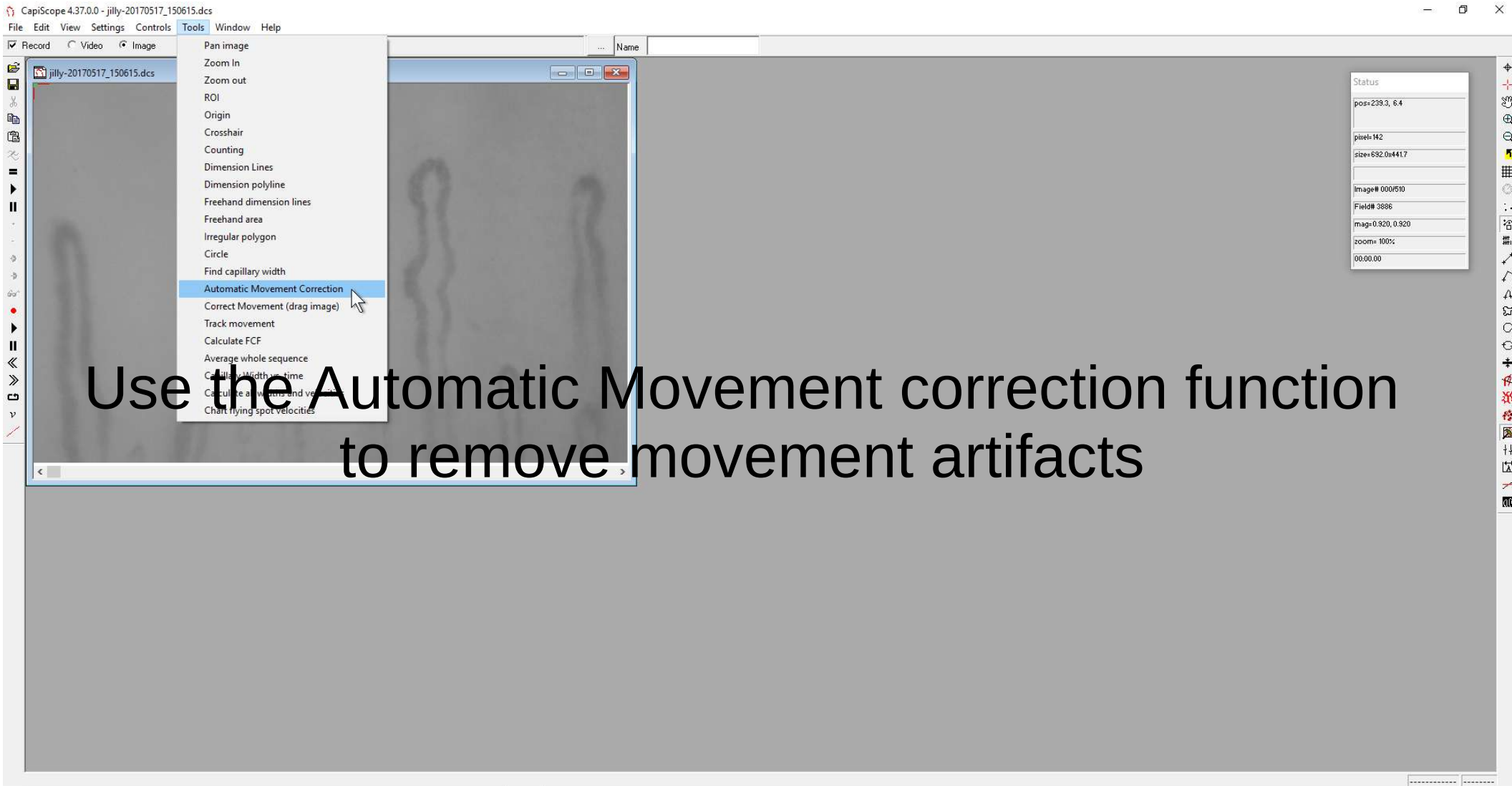
Open your recorded nailfold capillaroscopy video

For Help, pressF1

Automatic Movement correction



Automatic Movement correction



Automatic Movement correction parameters

Record Video Image to ... Name

jilly-20170517_150615.dcs

File Edit View Settings Controls Tools Window Help

pos=239.3, 6.4
pixels=142
size=692.0x441.7
image# 0001510
field# 3886
mag=0.920, 0.920
zoom= 100%
00:00.00

For Help, press F1

Movement correction Parameters

Reference window size (% of image size, centred in image). Larger will slow processing, but may include more features to correlate to. 40

Step between pixels in resolution window. 1= use every pixel, 2 every other pixel etc. Increase this value to speed up processing. 16

Method
Random points
Grid of points
Grid of lines

Low pass filter window size. Filters image before correlating image. Use zero for no filtering. 5

Range to check movement over (% of image size). Larger will slow processing, but will follow faster movements. 5

Resolution (in pixels/lines). Coarser (larger value) will speed up processing but at expense of coarse movement correction. 1

Limit (% of range). When movement exceeds this limit, the current image becomes the new reference image. 50

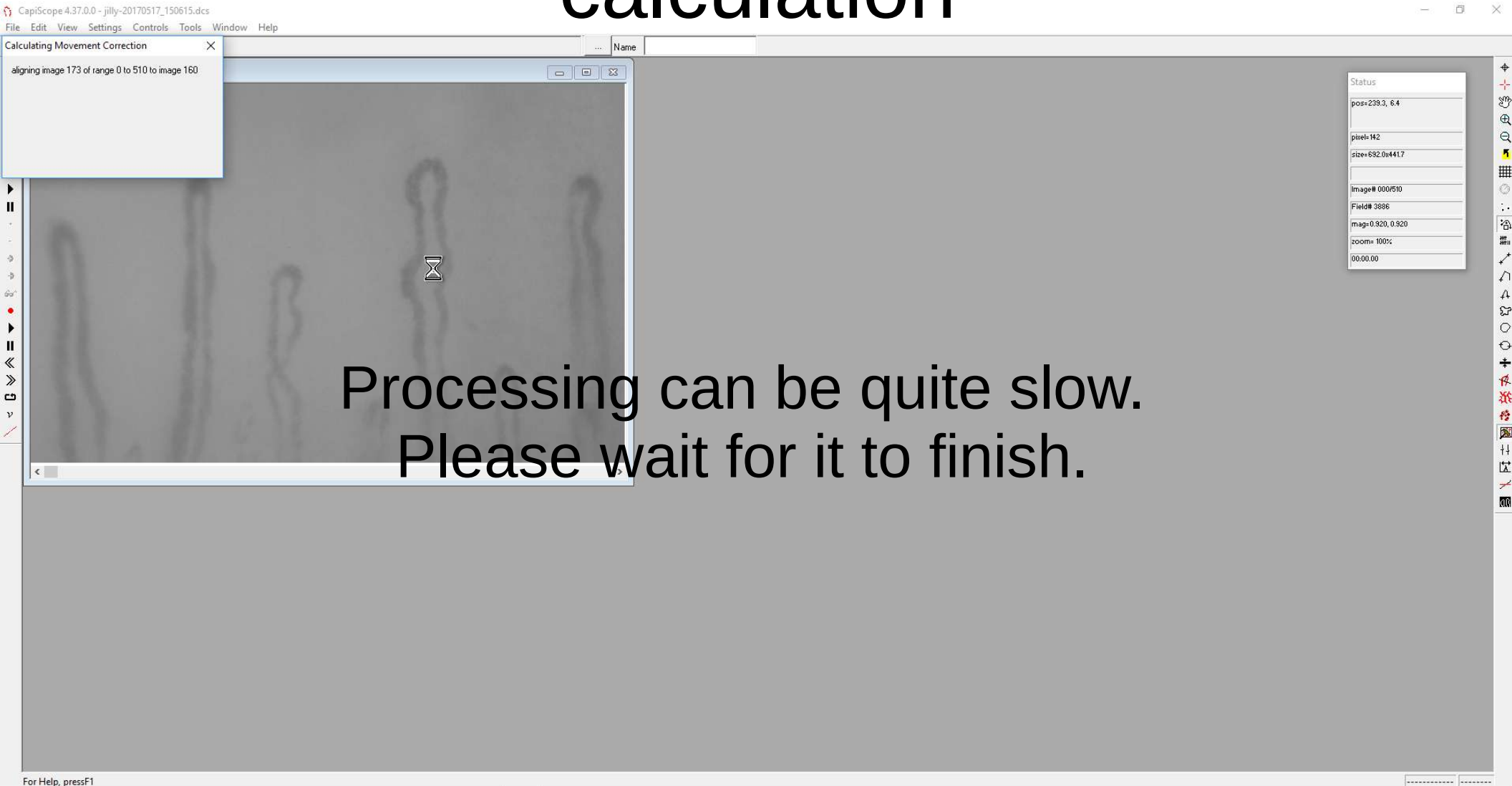
OK Cancel

You can improve processing speed by reducing the reference window size if there are capillaries in the centre of the image...

...and by increasing the step between pixels...

...and by reducing the range if the movement artifact is small or slow

Automatic Movement correction calculation



Loop Play

The screenshot displays the CapiScope 4.37.0.0 software interface. The main window shows a video player with a dark, blurry image. A tooltip labeled 'loop play' is visible over the left sidebar's playback controls. A 'Status' panel on the right provides technical details:

Status	
pos=	5.5435.3
pixels	140
size=	632.0x441.7
image#	000/510
Field#	3886
mag=	0.920, 0.920
zoom=	100%
	00:00.00

Use the loop play toolbar button to continuously play the video so that you can see the direction of flow

Play and repeat

Measurement line

The screenshot displays the CapiScope 4.37.0.0 software interface. The main window shows a grayscale image of three vertical, blurry shapes. A blue-bordered window titled 'jilly-20170517_150615.dcs' is overlaid on the image. A toolbar at the bottom left contains various icons, including a measurement tool. A status panel on the right side of the interface displays the following information:

Status
pos=637.7,338.7
pixels=129
size=632.0x441.7
image# 327/510
Field# 4540
mag=0.920, 0.920
zoom= 100%
00:10:30

At the bottom left of the interface, the text 'add measuring/dimension' is visible. A large text overlay in the center of the image reads: 'Use the measurement toolbar button to show the measurement line buttons'.

Measurement polyline

The screenshot displays the CapiScope 4.37.0.0 software interface. The main window shows a grayscale image of a capillary loop. A blue-outlined rectangle highlights the leftmost capillary loop. A text overlay explains that a polyline tool will be used to measure this loop. The software's menu bar includes File, Edit, View, Settings, Controls, Tools, Window, and Help. A toolbar at the top has buttons for Record, Video, Image, and Name. A status window on the right shows the following data:

Status	
pos=	637.7,338.7
pixels	129
size=	632.0x441.7
image#	178/510
Field#	4242
mag=	0.920, 0.920
zoom=	100%
	00:05.93

At the bottom left, the word "Polyline" is visible. The bottom right corner of the software interface shows a toolbar with various measurement tools, including a "polyline" button.

For this demo we'll measure the leftmost capillary loop. Since it is not straight we'll use the polyline toolbar button to draw a line which can follow the path of the capillary

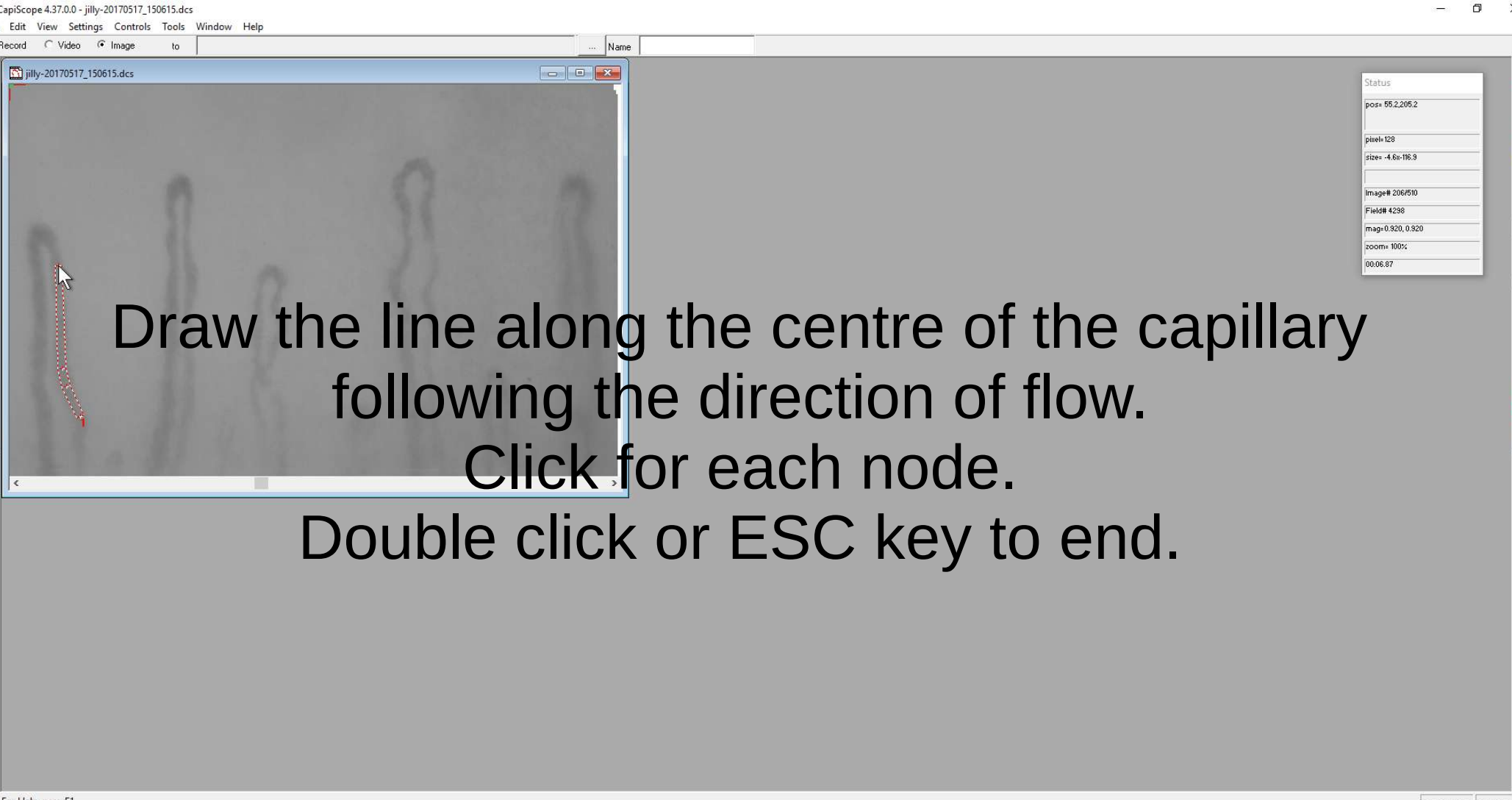
Drawing the Measurement line

The screenshot displays the CapiScope 4.37.0.0 software interface. The main window shows a video frame with a measurement line being drawn along a capillary. The text "Draw the line along the centre of the capillary following the direction of flow" is overlaid on the video frame. The software interface includes a menu bar (File, Edit, View, Settings, Controls, Tools, Window, Help), a toolbar (Record, Video, Image, to, Name), and a status window on the right. The status window displays the following information:

Status
pos= 626,343.3
pixels= 127
size= 17.5x-33.1
image# 346/510
Field# 4578
mag= 0.920, 0.920
zoom= 100%
00:11:53

For Help, press F1

Measurement line



The screenshot shows the CapiScope 4.37.0.0 interface. The main window displays a video frame with a measurement line drawn along a capillary. The line is composed of red dashed segments connected by small red dots (nodes). A mouse cursor is positioned at the start of the line. The software's menu bar includes File, Edit, View, Settings, Controls, Tools, Window, and Help. The toolbar contains various icons for recording, video, image, and measurement. A status window on the right displays the following information:

Status	
pos=	552,205,2
pixels	128
size=	-4.6x-116.9
image#	206/510
Field#	4238
mag=	0.920, 0.920
zoom=	100%
	00:06:87

For Help, pressF1

Draw the line along the centre of the capillary following the direction of flow.
Click for each node.
Double click or ESC key to end.

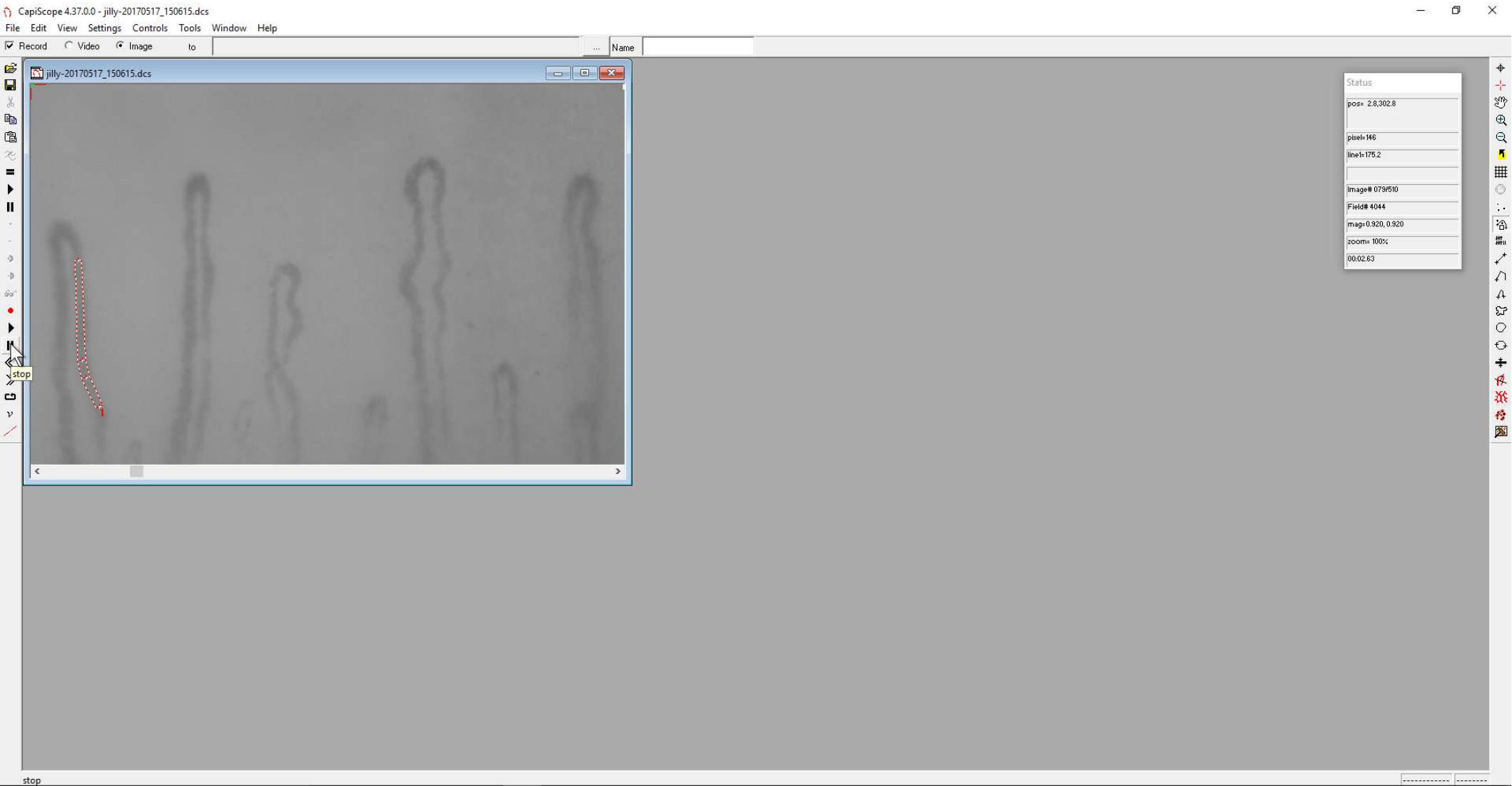
Line width

The screenshot displays the CapiScope 4.37.0.0 interface. The main window shows a video frame with a red dashed line tracing a path through a capillary. A context menu is open over the first node of the line, with the 'Set line width' option selected. To the right, a 'Histogram' window shows a distribution of pixel levels. Further right, a 'Status' panel displays various parameters. At the bottom, a 'Linescan' window shows a graph of velocity (um/s) versus time (seconds).

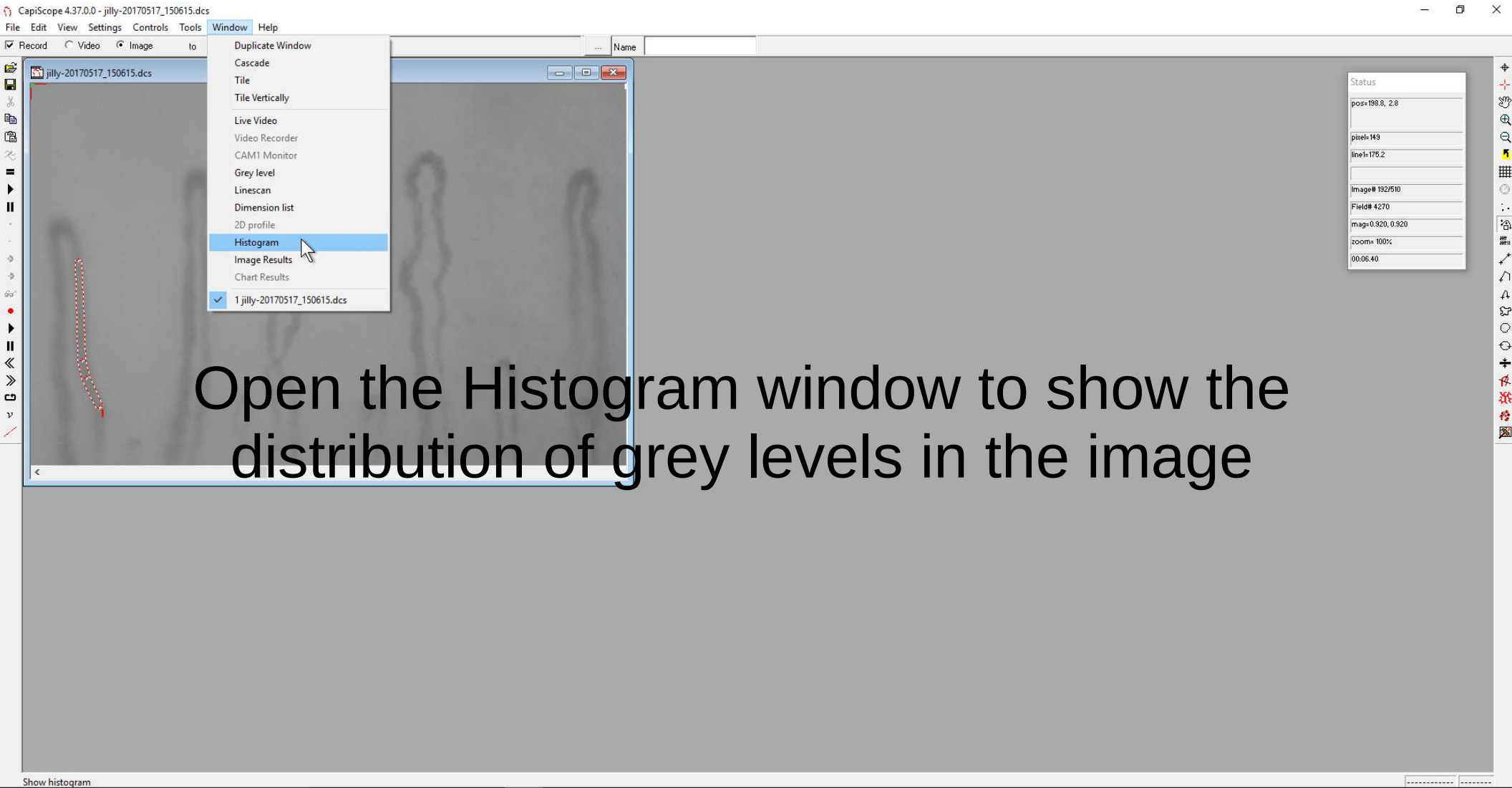
Set the measurement line width by right click on the first node of the line. Set the width to about the same width of the capillary. Enter line width in pixels.

Set line width

Stop loop play



Open Histogram Window



Adjusting brightness and contrast

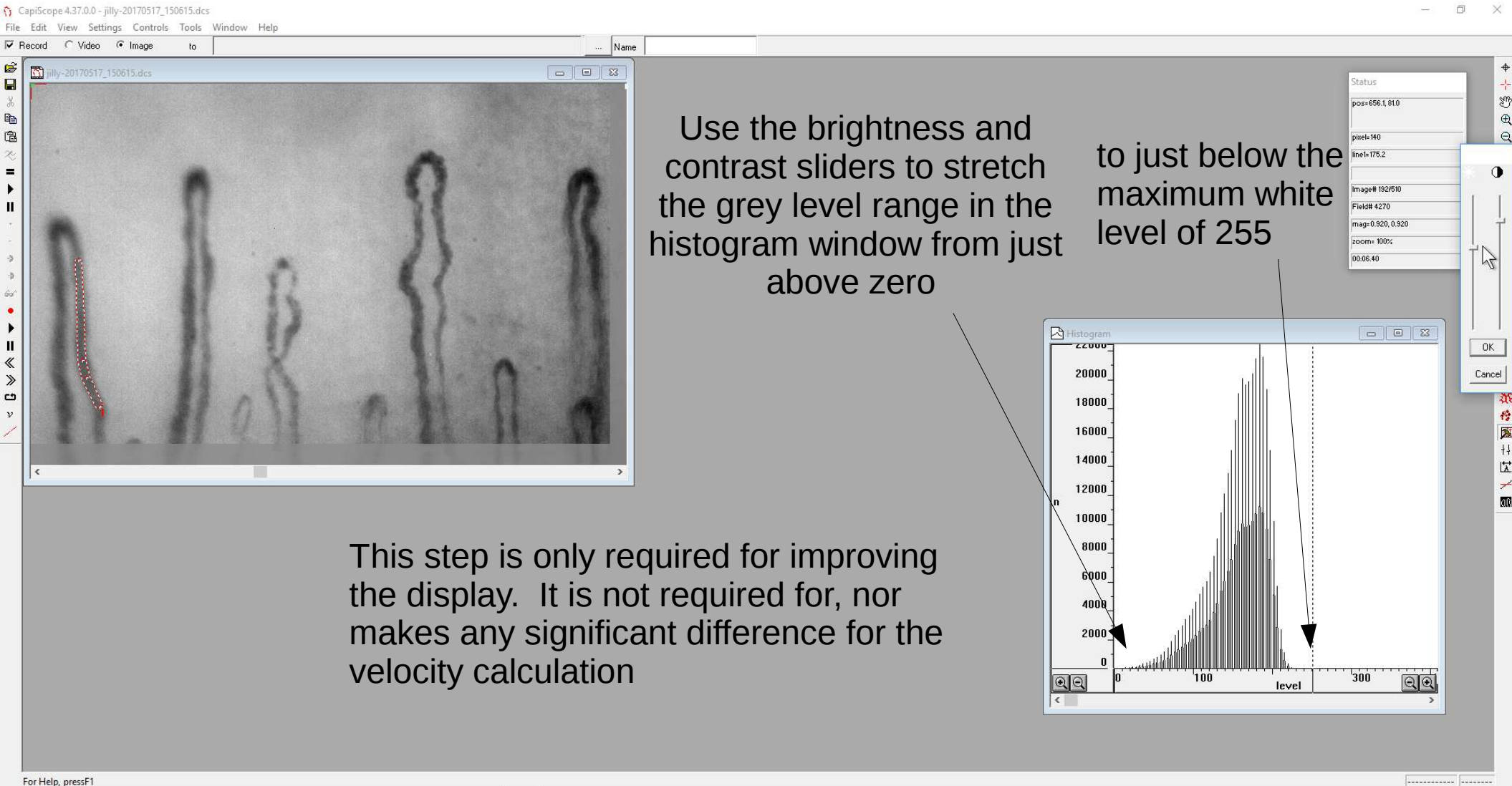
The screenshot displays the CapiScope 4.37.0.0 software interface. The main window shows a grayscale image of a person's silhouette. A red dashed line indicates a selection or measurement on the image. The interface includes a menu bar (File, Edit, View, Settings, Window, Help), a toolbar with various icons, and a status window on the right displaying parameters like $x = 307.000$ level and $y = 0.000$ n. A histogram window is open in the bottom right, showing a sharp peak at level 100. The histogram's y-axis is labeled 'n' and ranges from 0 to 22000, while the x-axis is labeled 'level' and ranges from 0 to 300. A large text overlay reads: "Use the Tools toolbar button to show the image processing buttons".

Adjusting brightness and contrast

The screenshot displays the CapiScope 4.37.0.0 software interface. The main window shows a grayscale image of a person's silhouette with a red dashed line indicating a measurement. A toolbar on the left contains various adjustment tools. A status window on the right provides technical details: pos=856,1,810; pixels=140; line=175.2; image# 132/510; field# 4270; mag=0.920, 0.920; zoom= 100%; 00:06:40. A histogram window is open in the bottom right, showing a sharp peak at level 100. The histogram's y-axis is labeled 'n' and ranges from 0 to 22000. The x-axis is labeled 'level' and ranges from 0 to 300. A vertical dashed line is positioned at level 300. The text 'Adjust brightness and contrast of current image.' is visible at the bottom of the software window.

Use the adjust toolbar button to open the brightness and contrast sliders

Adjusting brightness and contrast



Use the brightness and contrast sliders to stretch the grey level range in the histogram window from just above zero to just below the maximum white level of 255

This step is only required for improving the display. It is not required for, nor makes any significant difference for the velocity calculation

For Help, pressF1

Open the linescan window

The screenshot displays the CapiScope 4.37.0.0 software interface. The main window shows a grayscale image of a textured surface with a red dashed line indicating a scan path. The 'Window' menu is open, listing various analysis tools. The 'Linescan' option is highlighted, and a mouse cursor is positioned over it. Below the menu, a 'Histogram' window is open, showing a bar chart of pixel intensity levels. The histogram's y-axis is labeled 'n' and ranges from 0 to 22000. The x-axis is labeled 'level' and ranges from 0 to 300. A vertical dashed line is drawn at approximately level 250. The status bar at the bottom left reads 'Show/hide linescan window'.

Window menu items:

- Duplicate Window
- Cascade
- Tile
- Tile Vertically
- Live Video
- Video Recorder
- CAM1 Monitor
- Grey level
- Linescan**
- Dimension list
- 2D profile
- Histogram
- Image Results
- Chart Results
- 1 jilly-20170517_150615.dcs
- 2 Histogram

Status bar: Show/hide linescan window

Interlace

use separate samples for each interlaced field

If your video recording was recorded from a camera with interlaced video (RS170, CCIR, PAL, SECAM, etc), then set the *Use Interlace* option.

Acquiring the linescan

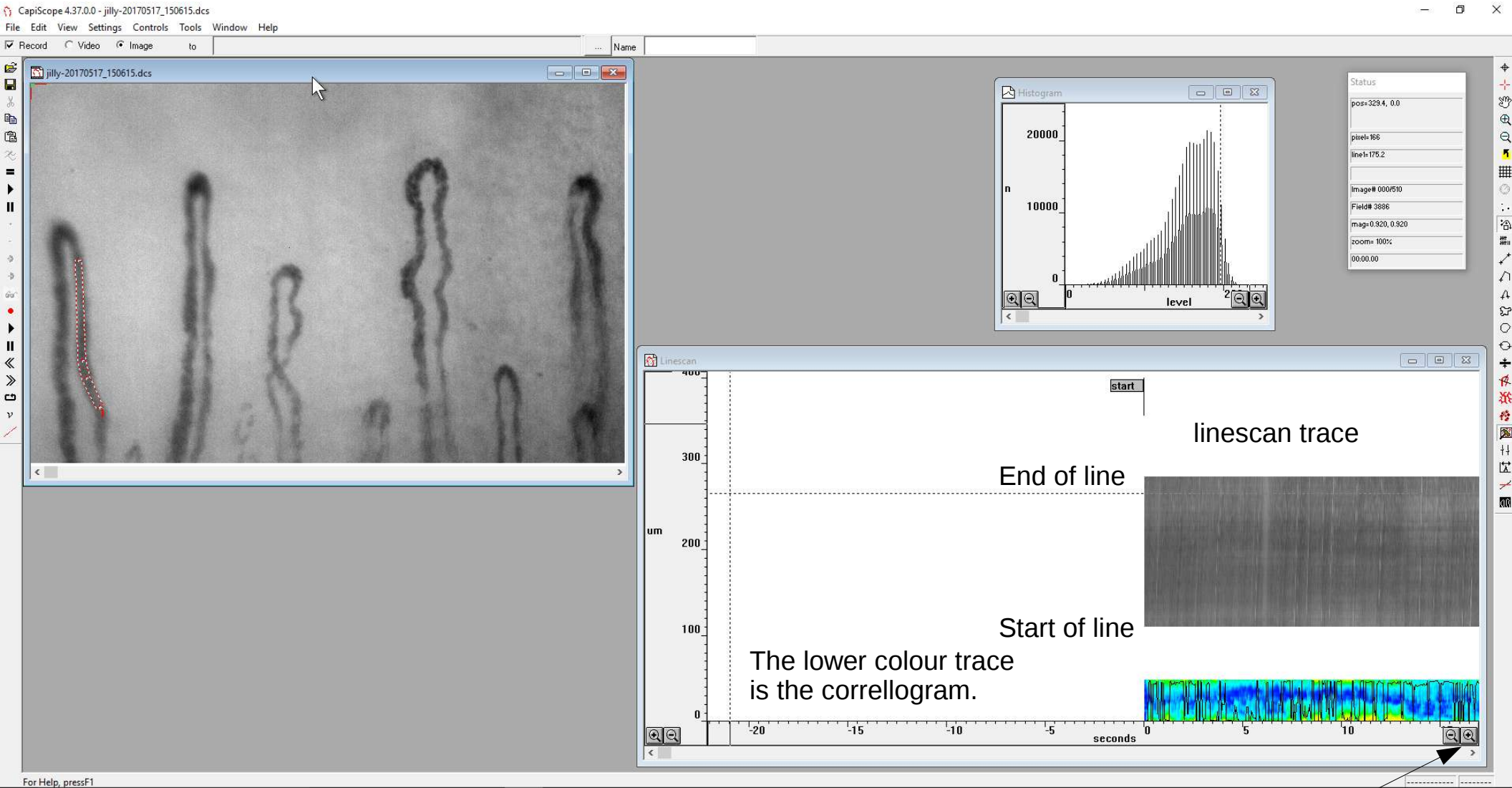
The screenshot displays the CapiScope 4.37.0.0 software interface. The main window shows a video feed of a textured surface with a red dashed line indicating a scan path. A text overlay reads: "Click on the title bar of the video window to make it the activate window". To the right, a "Histogram" window shows a distribution of pixel levels, with the x-axis labeled "level" and the y-axis labeled "n". Below the histogram is a "Status" panel with the following data: pos=168.4, 0.9; pixels=175; line=175.2; image# 000/510; Field# 3886; mag=0.920, 0.920; zoom= 100%; 00:00:00. At the bottom, a "Linescan" window shows a plot of intensity in $\mu\text{m/s}$ versus time in seconds. The y-axis ranges from 0 to 10000, and the x-axis ranges from 0 to 35 seconds. A vertical dashed line is positioned at approximately 2.5 seconds, and a horizontal dashed line is at approximately 9500 $\mu\text{m/s}$. The software title bar and menu options (File, Edit, View, Settings, Controls, Tools, Window, Help) are visible at the top.

Acquiring the linescan

The screenshot displays the CapiScope 4.37.0.0 software interface. The main window shows a video playback area with a red dashed line indicating the current video position. A 'play sequence' button is visible in the bottom-left corner of the video window. To the right, a 'Histogram' window shows a graph of pixel intensity levels, with a vertical dashed line indicating the current video position. Below the histogram, a 'Status' window displays various parameters: pos= 0.0244.8, pixels=179, line=175.2, image# 000/510, Field# 3886, mag=0.920, 0.920, zoom= 100%, and 00:00.00. At the bottom, a 'Linescan' window shows a graph of pixel intensity (um/s) versus time (seconds). The y-axis ranges from 0 to 10000 um/s, and the x-axis ranges from 0 to 35 seconds. A vertical dashed line is positioned at approximately 2.5 seconds, corresponding to the current video position.

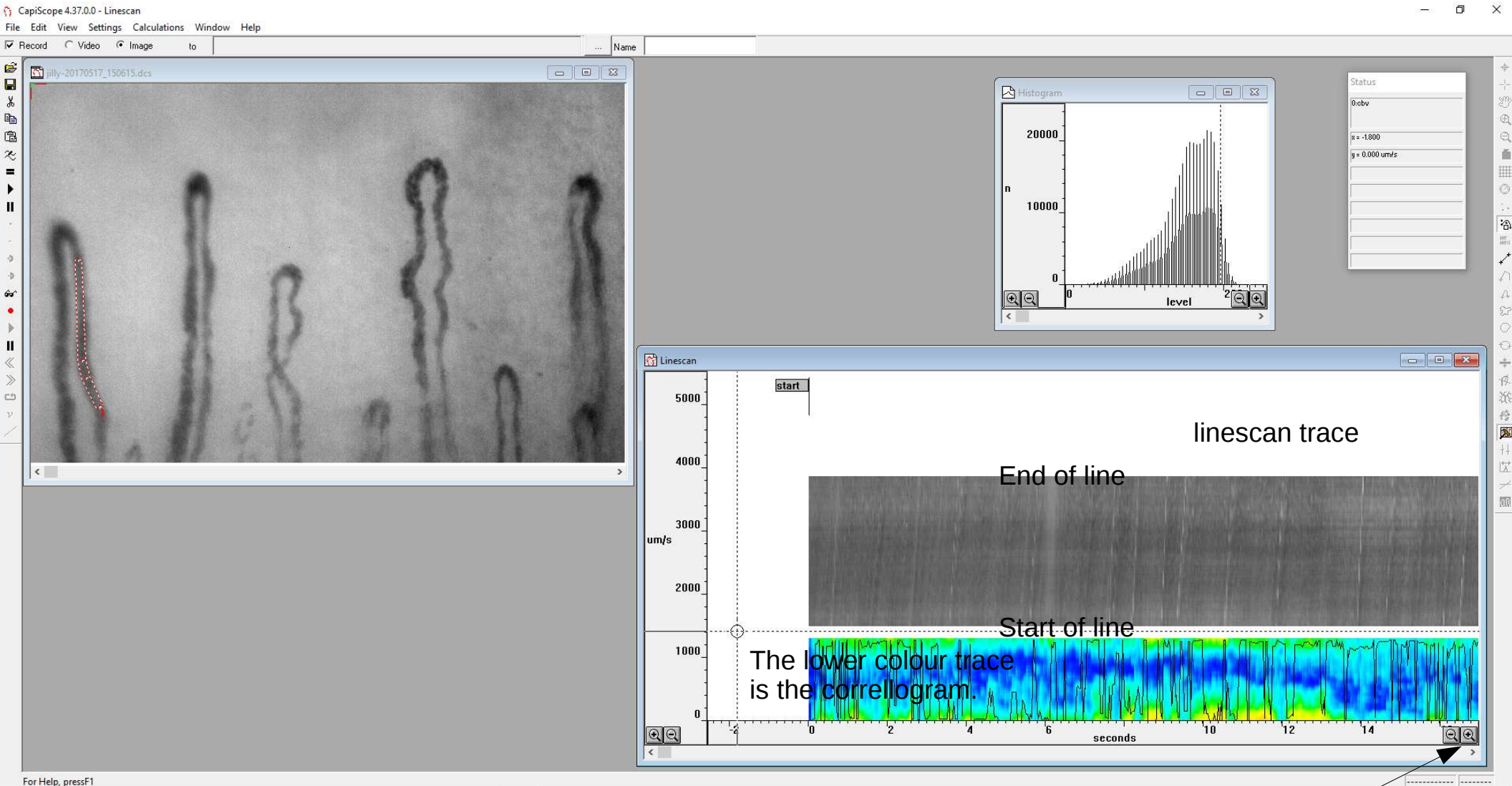
Click on the Play toolbar button to play the video and record the linescan. The linescan will start from the current video position. Any previous linescan will be overwritten.

Analysing the linescan



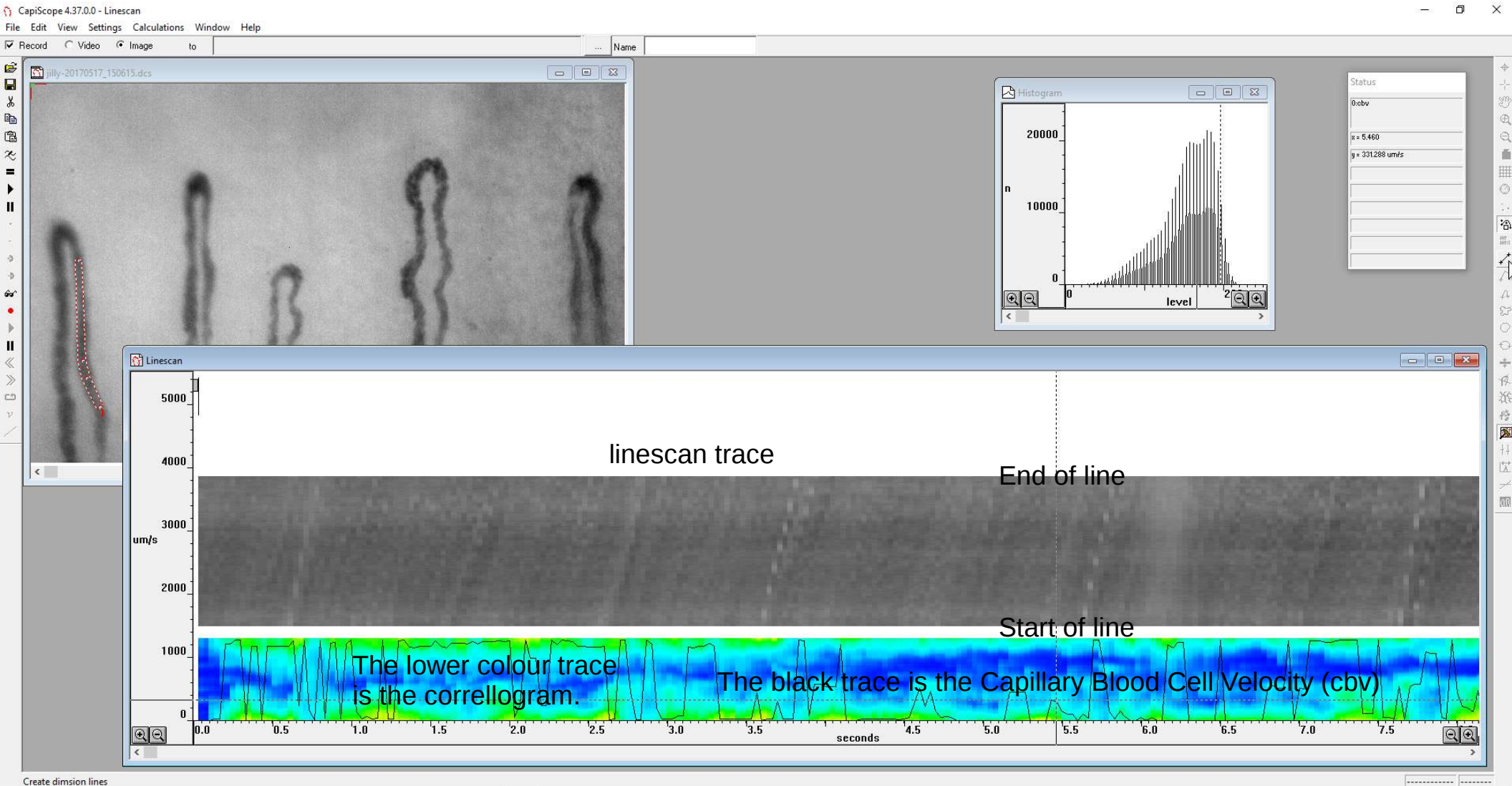
Expand the linescan traces

Linescan chart

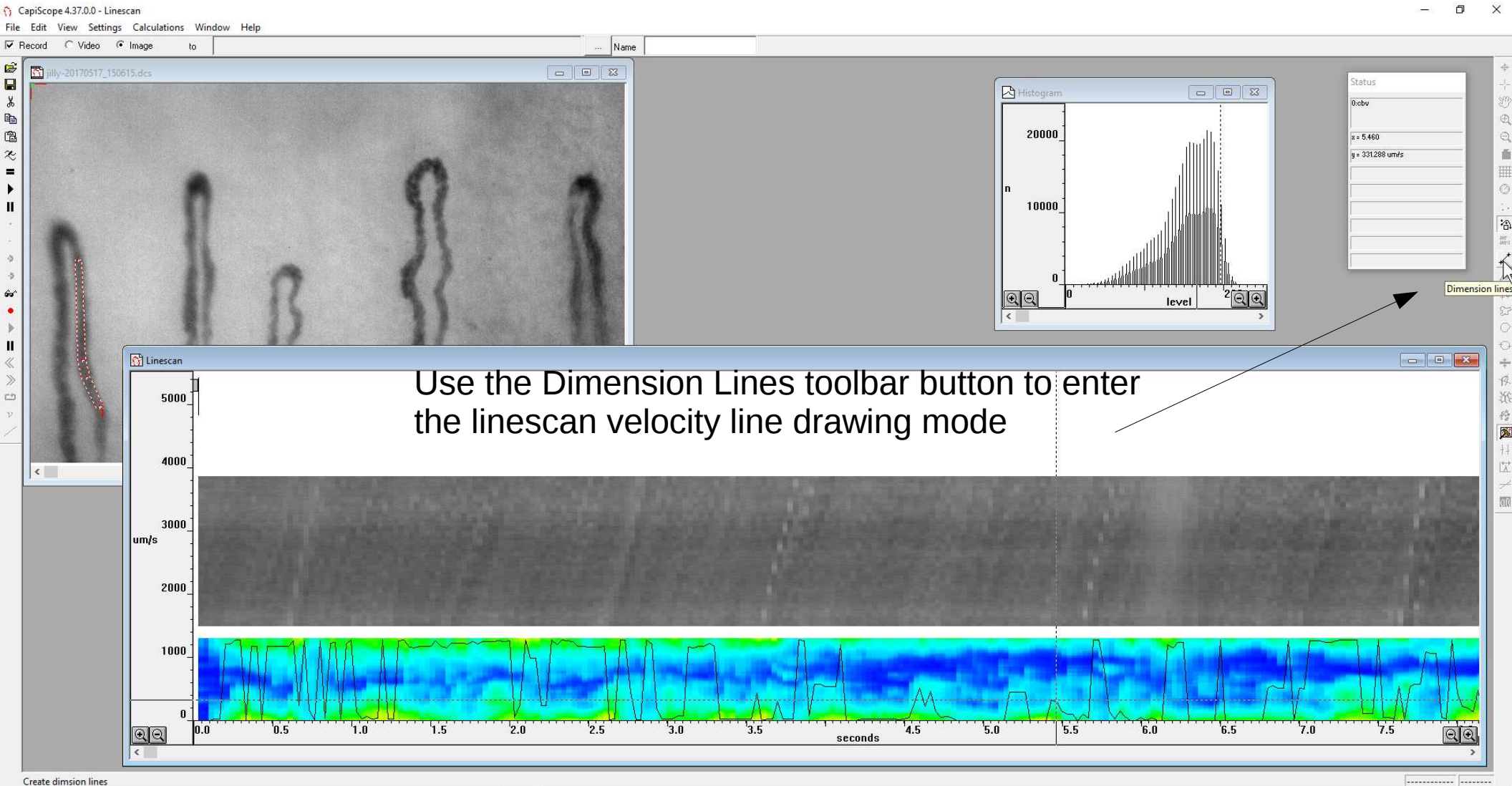


Expand the linescan traces

Linescan traces

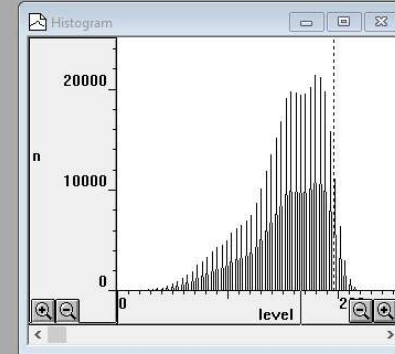


Estimating cbv

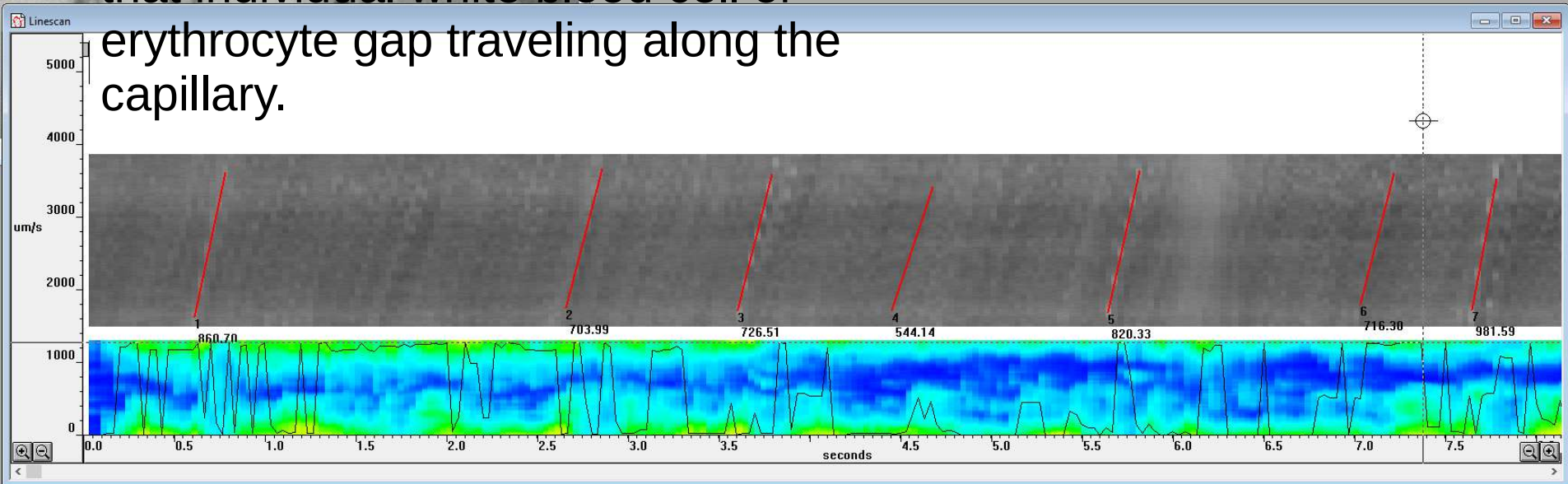


Estimating cbv

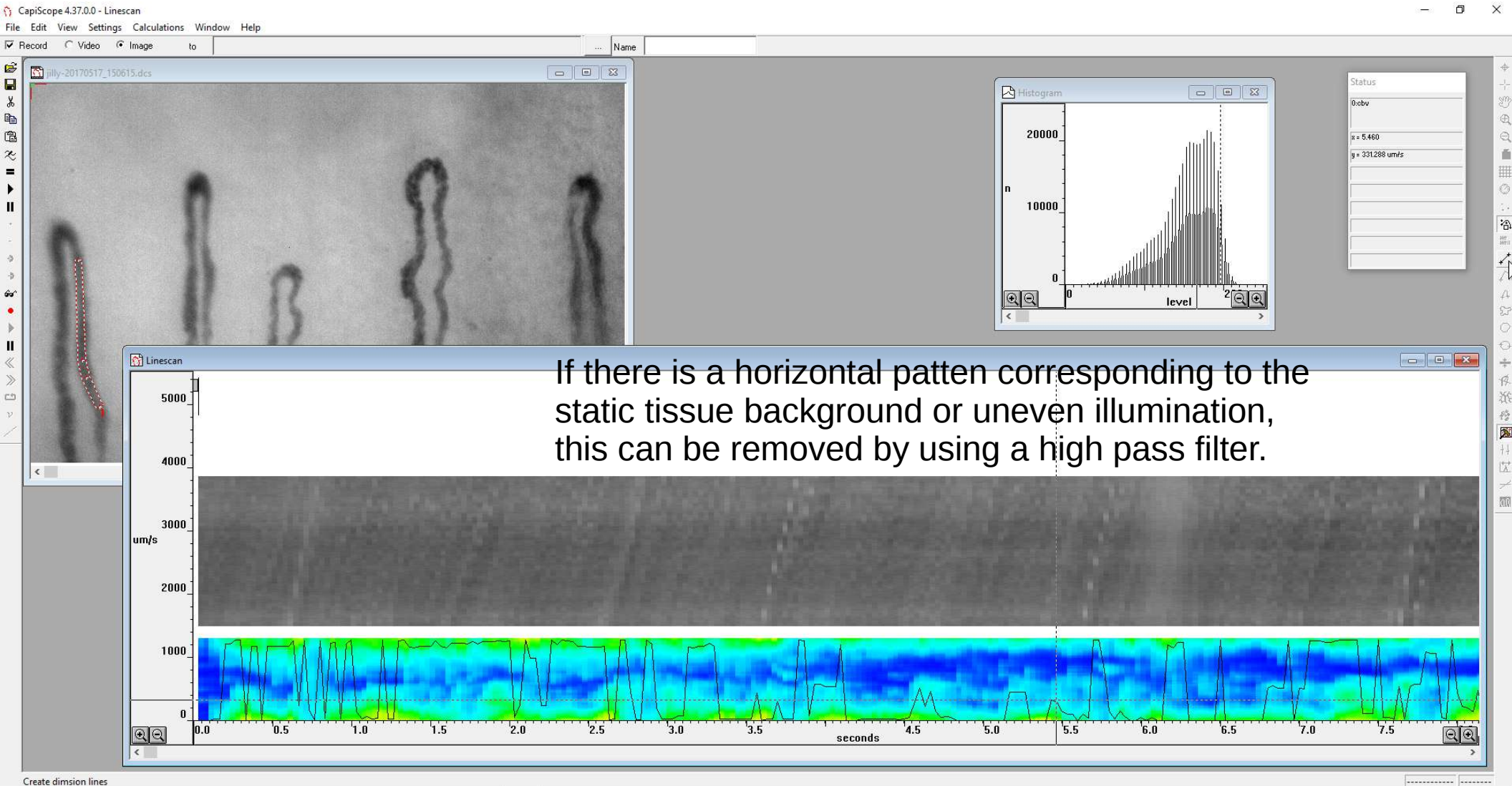
Draw lines following the sloping patterns on the linescan trace. The slope of the line gives the velocity of that individual white blood cell or erythrocyte gap traveling along the capillary.



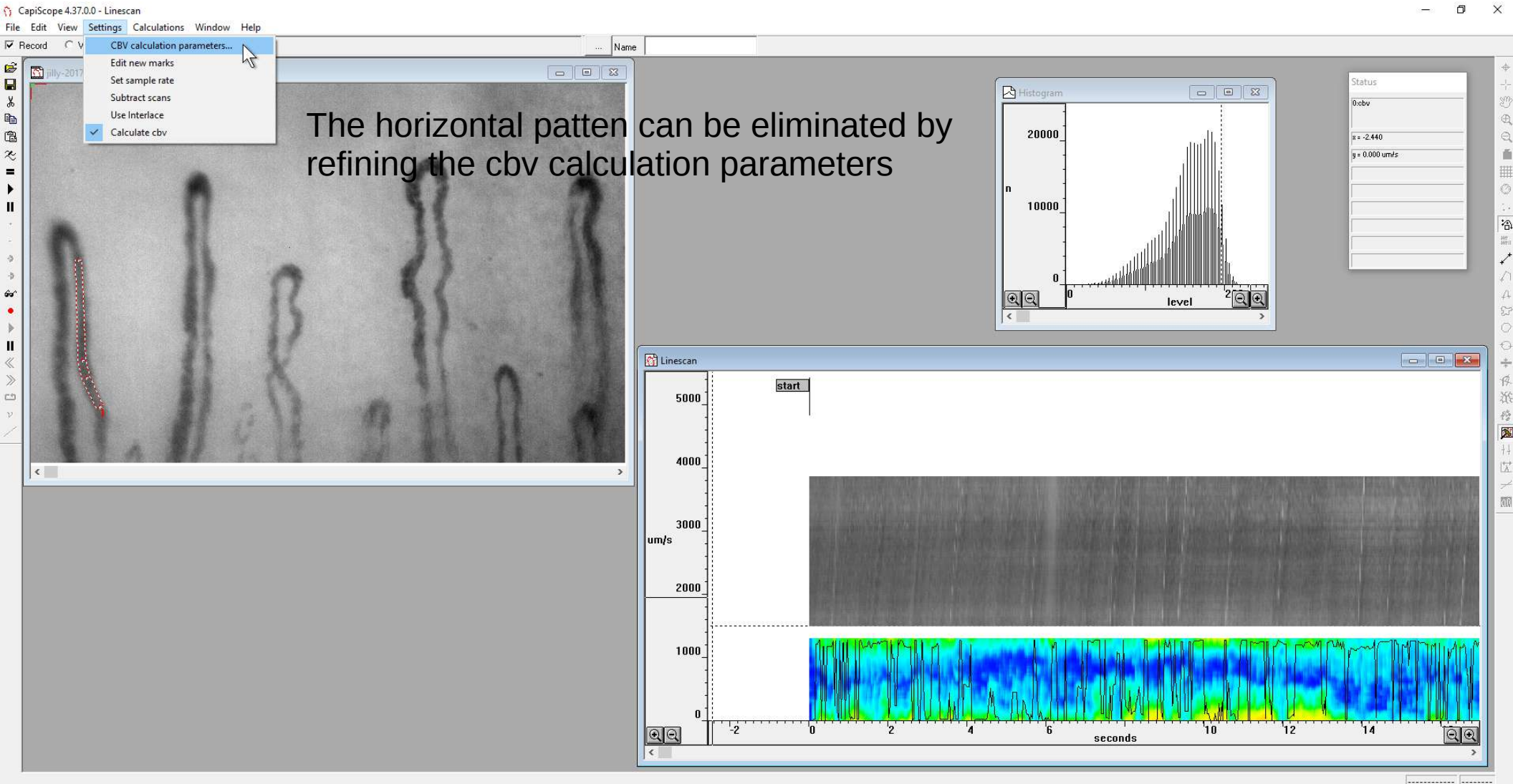
Status	
0:cbv	
\bar{x}	= 7.375
\bar{y}	= 1283.742 um/s



Analysing the linescan



Refining cbv parameters



Refining cbv parameters

The horizontal pattern can be eliminated by refining the cbv calculation parameters. Enable the high pass filter.

Since our estimated velocity is close to the full scale range, we can increase the maximum velocity by reducing the sample period between correlations

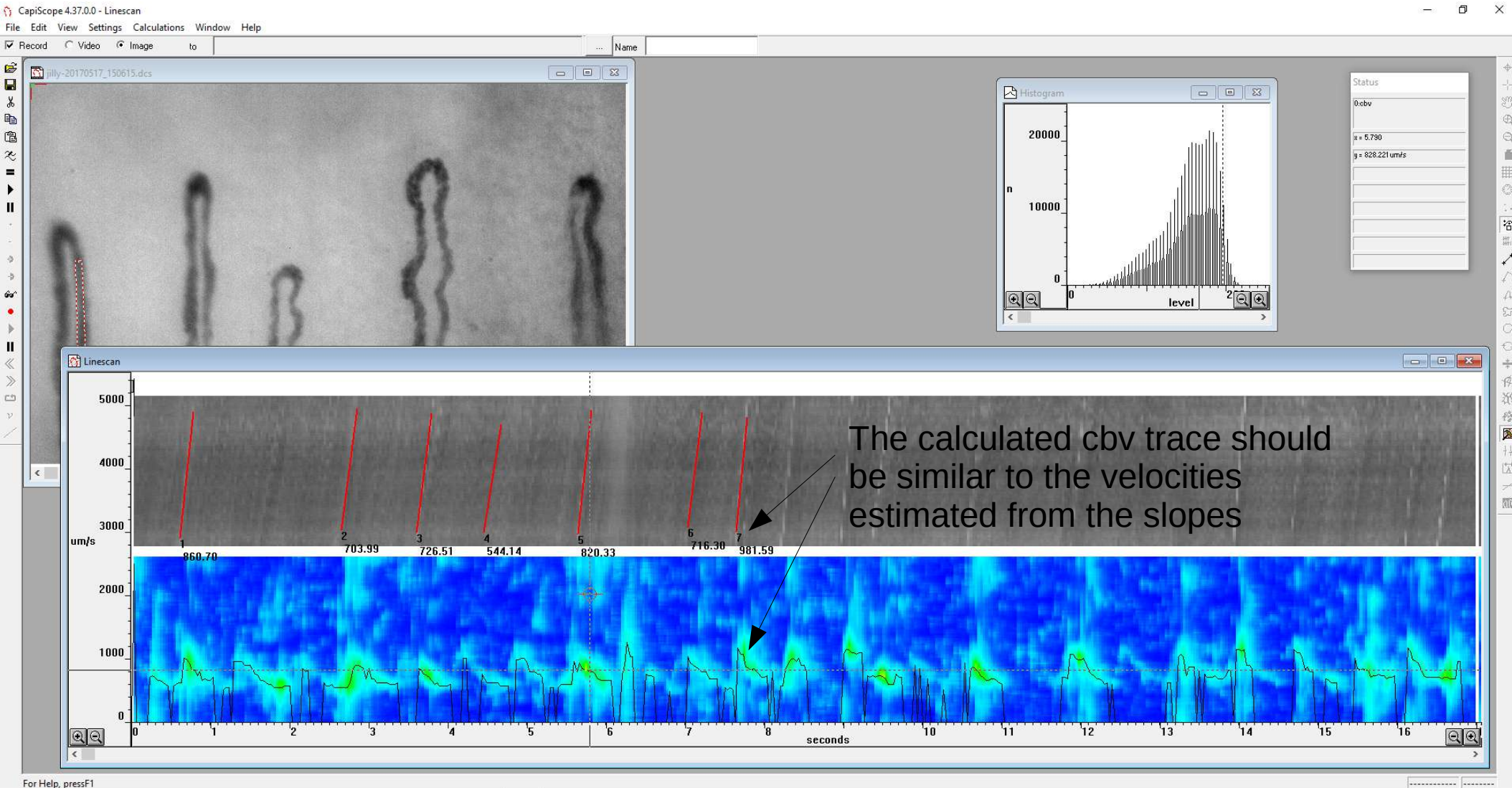
CBV calculation parameters

- cbv method from linescan
 - Spatial correlation
 - Hough Transform (fast flows)
 - Temporal correlation
- Enable linescan high pass filter
 - smoothing factor: 0.1
 - No. of correlations to smooth: 4
 - No. of linescan sample periods between correlations: 1
 - Correlation coefficient lower acceptable limit: 0.2
 - Use 2D correlation. include zero velocity peaks
 - No. of points for temporal correlation: 10

OK Cancel

For Help, press F1

Recalculated cbv



average cbv

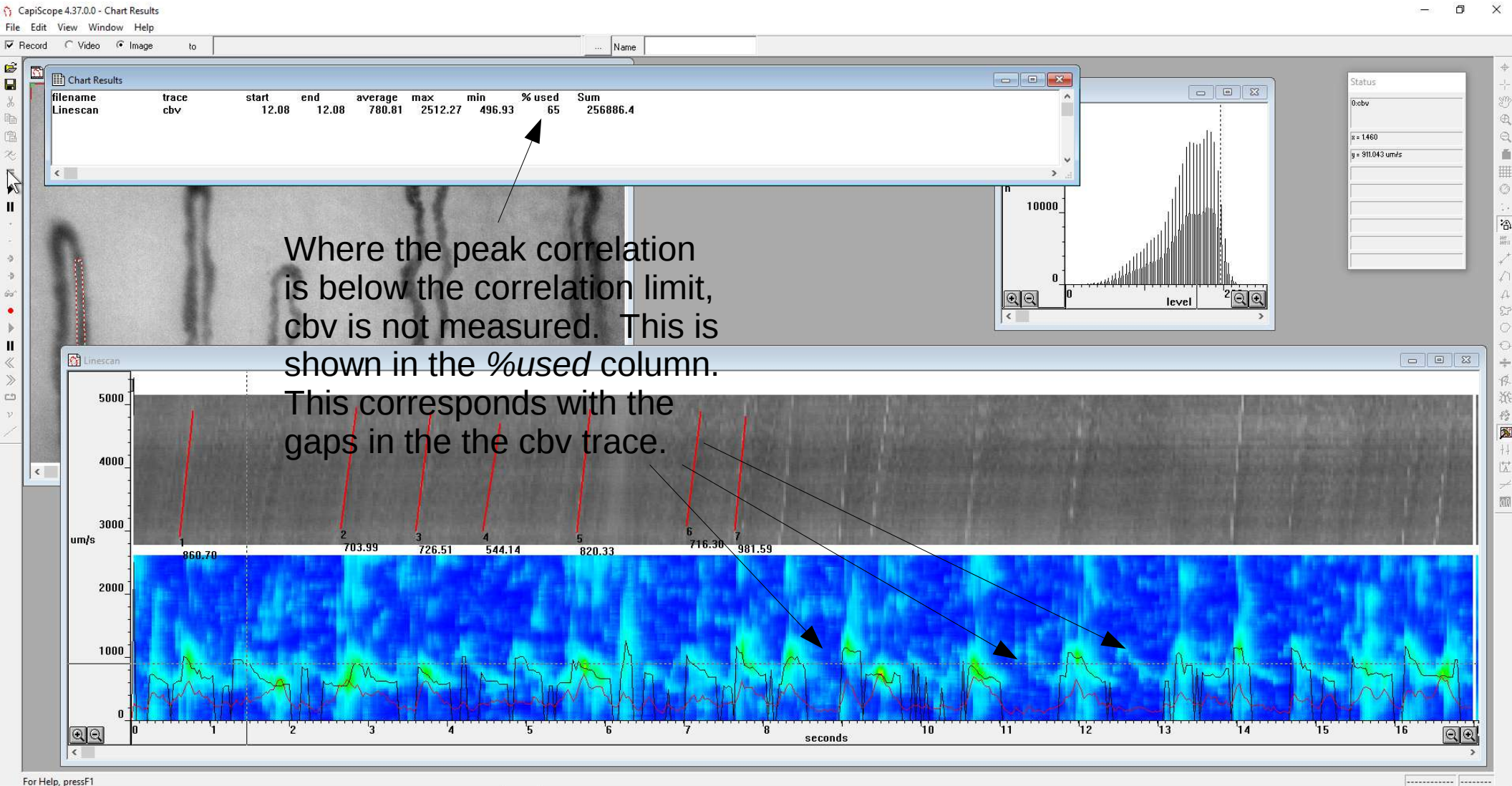
The screenshot displays the CapiScope 4.37.0 interface. At the top left, the menu bar includes File, Edit, View, Settings, Calculations, Window, and Help. Below it are buttons for Record, Video, Image, and a Name field. The main window shows a video frame of a biological specimen. A toolbar on the left contains an 'average' button, which is highlighted by an arrow and the text 'Use the keyboard = key or average toolbar button'. To the right, a 'Histogram' window shows a distribution of values with a peak around 1460. A 'Status' window on the far right displays '0:cbv' and 'x = 1460'. At the bottom, the 'Linescan' window shows a plot of velocity (um/s) over time (seconds). The plot has a y-axis from 0 to 5000 and an x-axis from 0 to 16. Red vertical lines mark specific time points with their corresponding velocity values: 1 (960.70), 2 (703.99), 3 (726.51), 4 (544.14), 5 (820.33), 6 (716.30), and 7 (981.59). A status bar at the bottom left reads 'Calculate average of selection'.

Use the keyboard = key or average toolbar button

Use the keyboard TAB key to step through the linescan traces until the *cbv* trace is active

Calculate average of selection

average cbv



Correlation trace

Use the keyboard TAB key to step through the linescan traces until the *correlation* trace is active.

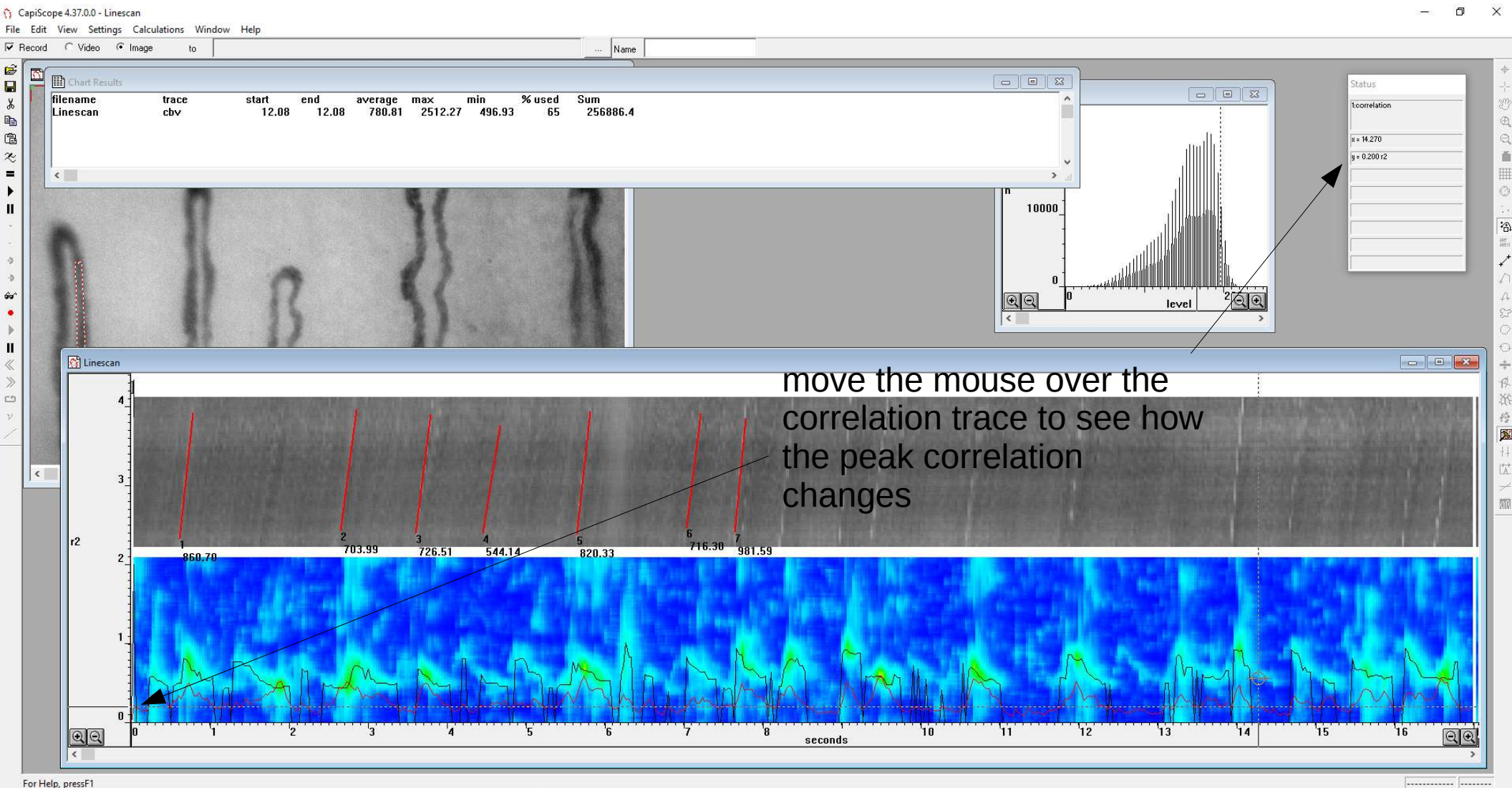
Use the *hide trace* toolbar button to show the correlation trace

Status

r	0.350
g	0.301r ²

Hide/show Active Trace

Choosing a correlation limit



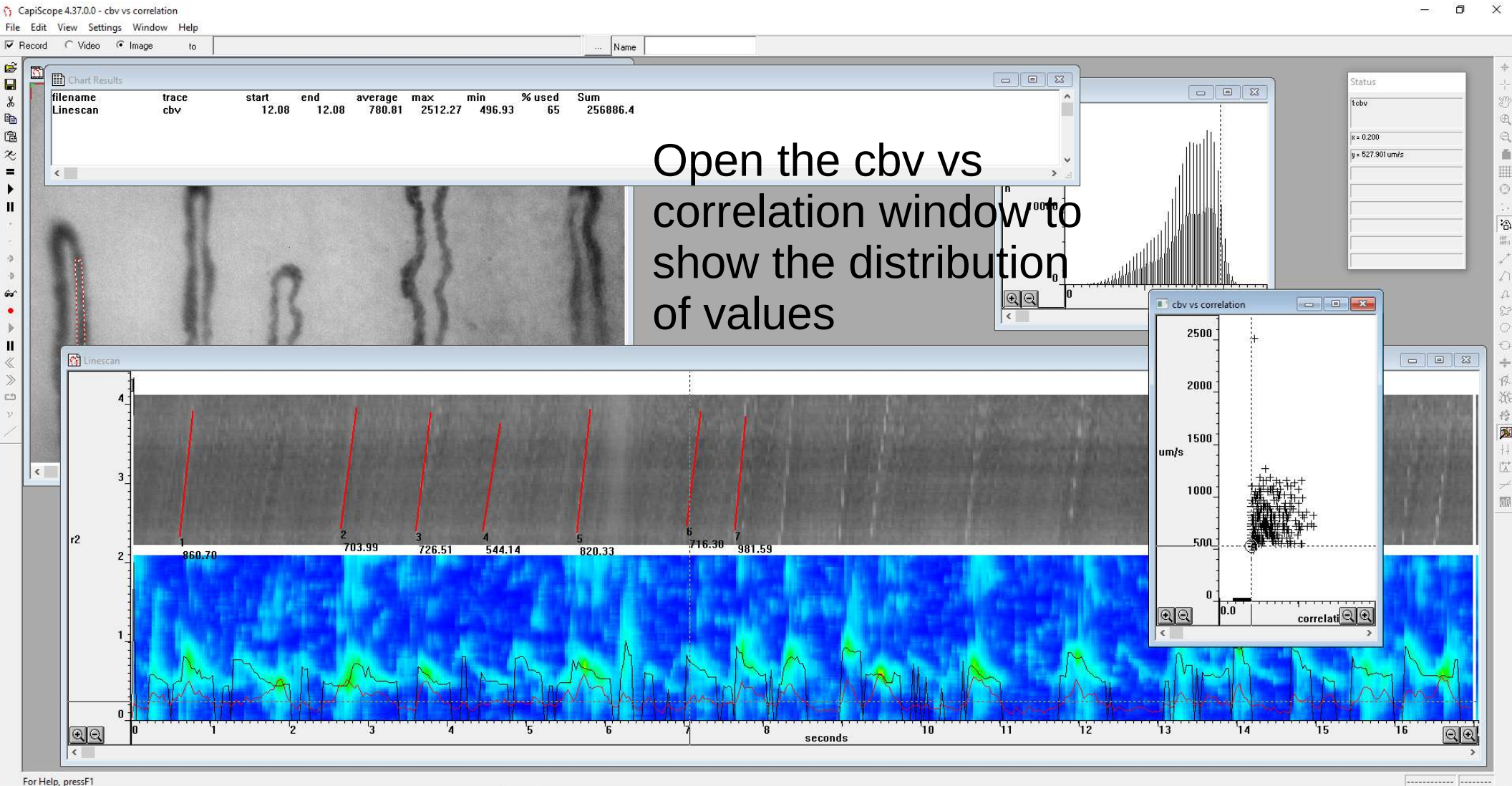
Open cbv vs peak correlation

The screenshot displays the CapiScope 4.37.0.0 software interface. A 'Window' menu is open, highlighting the 'cbv vs correlation' option. A small window titled 'cbv vs correlation' is visible, showing a histogram of values with a mean of 7.070 and a standard deviation of 0.24412. The main window shows a heatmap chart with a y-axis labeled 'r2' and an x-axis labeled 'seconds'. The chart displays a series of peaks, with the following time values: 960.70, 703.99, 726.51, 544.14, 820.33, 716.30, and 981.59. A status panel on the right shows the correlation statistics.

Open the cbv vs correlation window to show the distribution of values

Time (seconds)	r2
960.70	~3.8
703.99	~3.8
726.51	~3.8
544.14	~3.8
820.33	~3.8
716.30	~3.8
981.59	~3.8

cbv vs peak correlation



Adjusting the correlation limit

Chart Results

filename	trace	start	end	average	max	min	% used	Sum
Linescan	cbv	12.08	12.08	780.81	2512.27	496.93	65	256886.4

CBV calculation parameters

cbv method from linescan

- Spatial correlation
- Hough Transform (fast flows)
- Temporal correlation

Enable linescan high pass filter

smoothing factor

No. of correlations to smooth

No. of linescan sample periods between correlations

Correlation coefficient lower acceptable limit

Use 2D correlation. include zero velocity peaks

No. of points for temporal correlation

OK Cancel

Reduce the correlation limit to increase the number of cbv points.

Linescan

r2

seconds

For Help, press F1

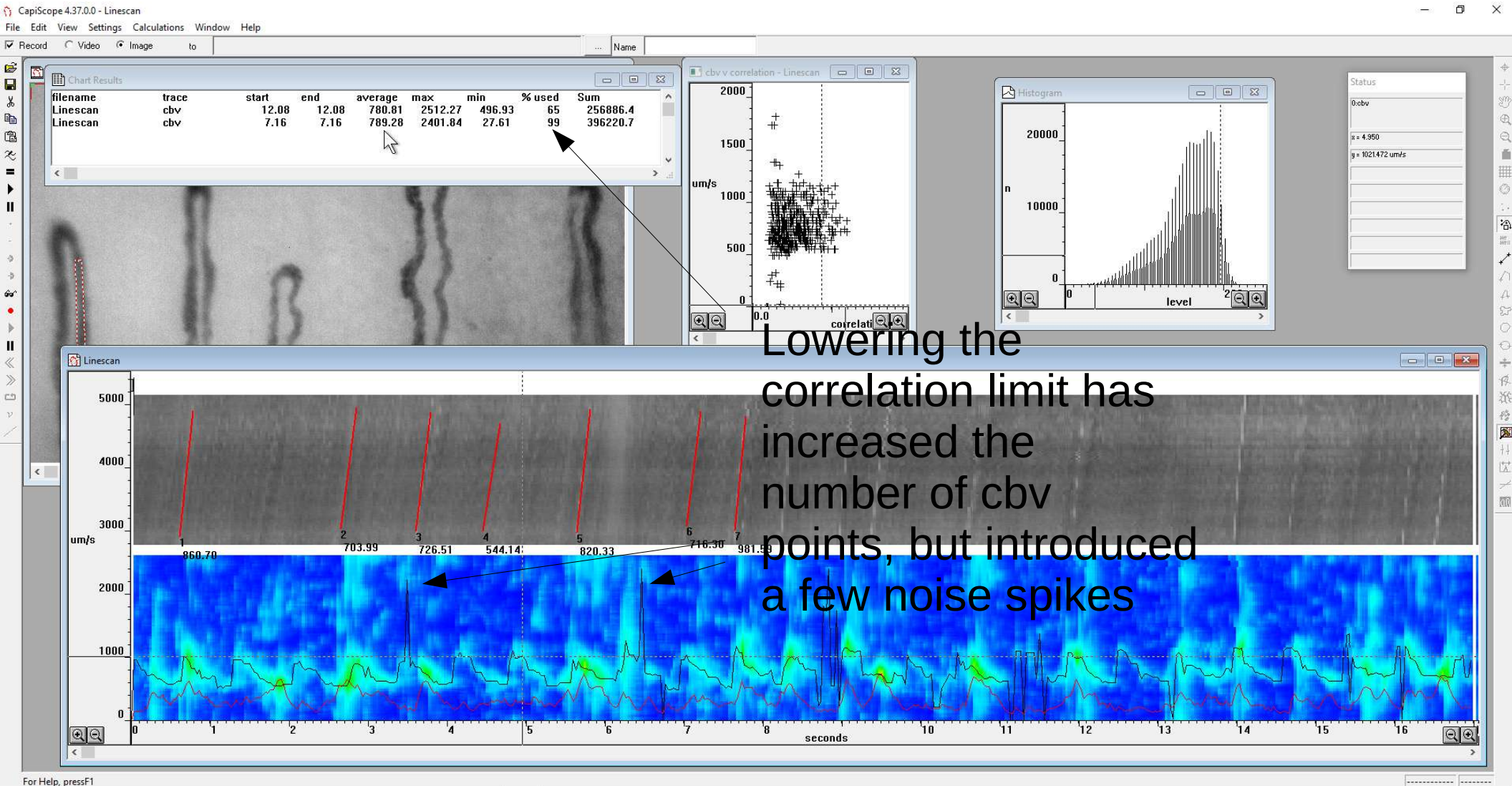
Status

r correlation

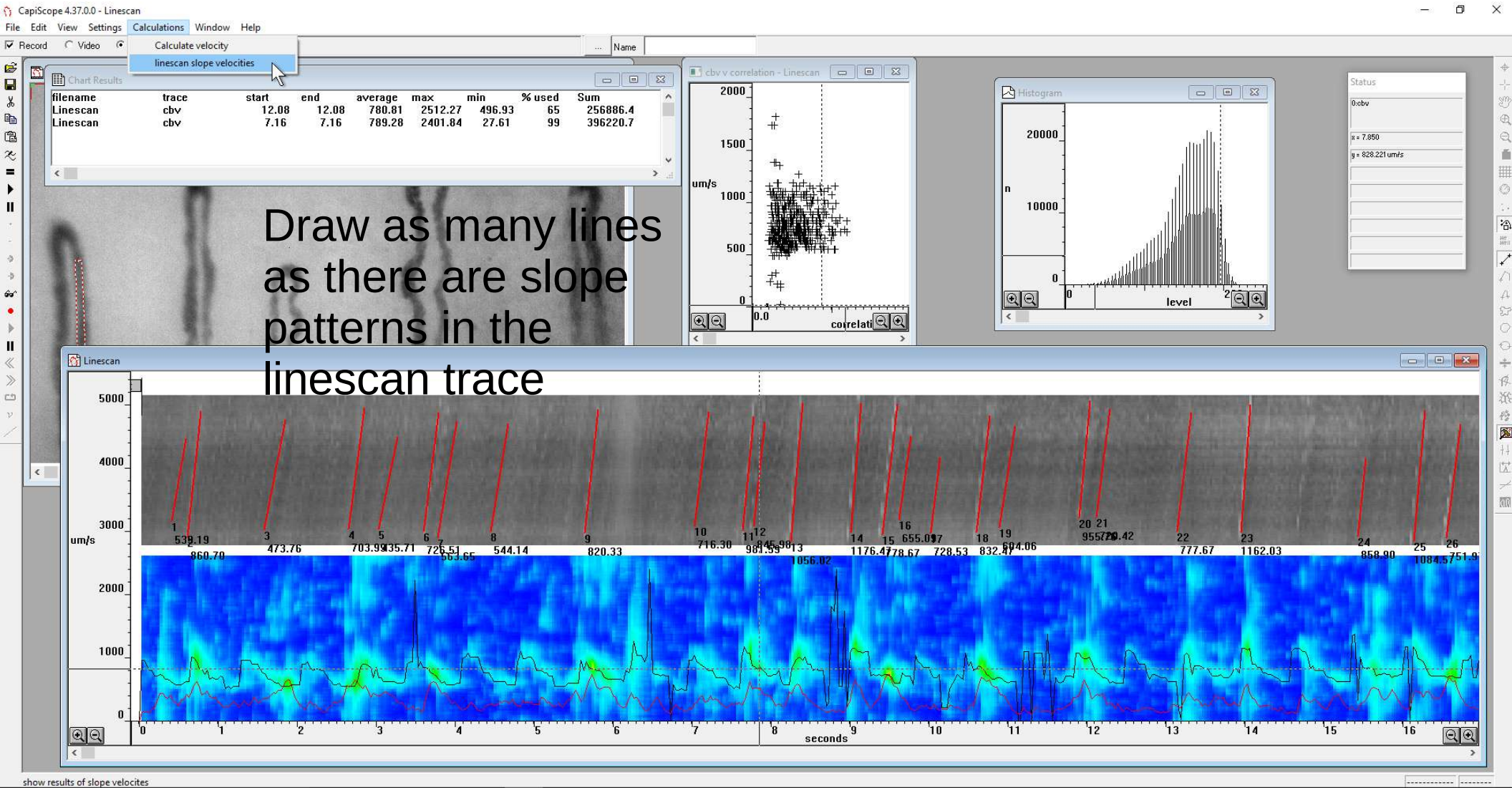
x = 7.070

y = 0.244 r2

Recalculated cbv



Cbv from velocity slopes



Cbv from velocity slopes

