VIC-3D 9 Setup Procedures

The procedures outlined below should be used as a guide for the initial setup of the VIC-3D 5MP system. Please note that more detailed procedures for the VIC-3D system can be found in your VIC-3D Testing Guide and VIC-3D User Manual. This step-by-step guide is written to help users achieve a very good calibration, speckle pattern, and overall good quality data.

Contents

I. System Assembly 1

II. Lens Selection 2

III. Camera Positioning 3

IV. Speckling 3

V. Focusing 4

VI. VIC-3D Calibration 6

VII. Post-Processing Speckle Check 9

VIII. Conclusion 12

I. System Assembly

- Set up your tripod legs next to the testing area. A symmetrical setup is a good setup!
- Connect the tripod head to the tripod legs.
- Connect the aluminum channel mounting “slide-block” to the tripod “quick-release” bracket.
- Secure the quick-release bracket tightly with a flat-head screwdriver.
- Connect the quick-release/slide-block to the tripod head.
- Push on the tripod-head lever to secure the quick-release/slide-block assembly firmly.
- Slide the extrusion bar into the slide-block about half way, while feeding the “T-nut” into the extrusion channel.
- Mount the hinge to the end of the extrusion bar using the 5mm Allen driver.
- Mount the second extrusion bar perpendicular to the first extrusion bar via the hinge.
- Secure the mounting system just enough so that the components do not move.
- Remove your cameras from the case, and mount them to the extrusion bar. Be sure to mount the cameras so that the swivel adjustment is to the rear. This makes it easier to adjust the angle of each camera.
- Connect each camera to the computer using the provided USB 3.0 cable. Be sure to fasten the cables to the cameras using the provided small flat-head screwdriver.

For more information about your system, contact support@correlatedsolutions.com
or visit the support panel at www.correlatedsolutions.com/support.

II. Lens Selection

When selecting a lens, a few parameters must be considered. Ideally, both cameras should use the exact same lenses, and the stereo angle should be approximately 30 degrees, with 15-45 degrees being acceptable. For wide angle lenses (such as the Schneider 8mm c-mount lens), a larger stereo angle is necessary to achieve the best measurement resolution due to the increased lens distortion. Below is an image of the Schneider Compact Series 8mm c-mount lens.

Figure 1: Schneider 8mm lens





The table below is an approximation for which lenses to choose based on your field of view (FOV). This should be used to choose a lens that best fits your setup.

Lens Focal Length	Working Distance: FOV
8mm	1:1
17mm	2:1
35mm	4:1
75mm	9:1
100mm	12:1

Figure 2: The table above approximates the ratio between the working distance and the FOV for the 5MP 2/3" sensor. For example, an 8mm lenses will achieve a FOV of approximately 100mm at a working distance of 100mm.

III. Camera Positioning

- To assist in setting up the cameras, start VIC-Snap to view a live image set.
- Roughly position stereo cameras based on the field of view (FOV) required.
- Fully open the aperture on both lenses. Opening the aperture decreases your depth of field, which ensures that when you focus the lenses, you are focusing on your specimen at the center of the depth of field. You will close the aperture to about 50-80% before testing.
- A window is shown for each camera in the system. The red areas in each image indicate overdrive/saturation, where the pixel is driven to its highest possible brightness value.
- Decrease or increase the exposure time until red is minimal on surface of specimen. There is no need to add light during this process. Room lighting may be used.
- Roughly adjust focus for ease of positioning. This is done by loosening the collar with the 2mm Allen Wrench, then rotating the front portion of the lens.
- Position cameras for optimal overlap on specimen's surface.

IV. Speckling

- Begin by preparing the region of interest on your specimen by masking off the area you want to measure with masking tape.
- The ideal speckle pattern should be applied using the following steps:
  a. Speckles should be between 3 – 5 pixels in size. This can be determined by drawing and numbering various size black dots on a piece of paper, placing the piece of paper in the field of view of the cameras at the same location (plane) of your specimen (use a little tape to hold it in place), then digitally zooming in the live image in VIC-Snap, and counting the number of pixels on the monitor across each of the black dots. Once you have chosen an appropriate speckle size, use this as a reference when applying the speckle pattern.
  b. White on black or black on white are equally acceptable speckle patterns. If your specimen is naturally black or white, you may not need to apply a white or black base coat. However, the natural base color must NOT be reflective. When in doubt, simply apply a base coat using **FLAT** white or black spray paint. Correlated Solutions recommends Rust-Oleum Ultra Cover 2X typically found at your local hardware store (images shown below).

Figure 3: Rust-Oleum Ultra Cover 2X FLAT White and Black Spray Paint

c. Make sure your specimen surface is clean and free of oil. Use rubbing alcohol or acetone for metals, and for other materials use a lint-free cloth and water.
d. Your base coat should cover the surface completely and evenly. Make sure there are no thin sections that may cause glare issues (typically with metals), but also make sure that you do not apply too much paint that will cause the paint to run.
e. Apply your speckles:
   - Using spray paint: Apply your speckles using the appropriate amount of pressure on the paint nozzle. Full pressure and a larger stand-off distance (approx. 3-5 feet) will produce a fine pattern (for FOV 1 to 2"), and light pressure and a shorter stand-off distance (approx. 6-12") will produce a coarse pattern.
   - Using the VIC Speckle Kit: Apply ink speckles using a stamp roller or rocker. When using the stamp roller, make several passes to apply enough speckles.
   - To use the stencils, mount the stencil to your specimen and apply paint with several quick passes over the stencil.
f. Good coverage is important! You want about 50/50 white-black coverage. You may find it tempting to stop after just a small amount of speckles are applied, but a good correlation requires a strong contrast over your subset window, which may only be 33 x 33 pixels for example. Below is an example of an ideal focused speckle pattern:

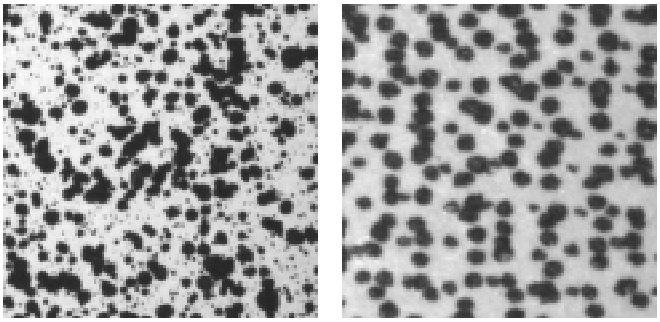


Figure 4: Digitally zoomed-in images from the 5MP CCD camera of ideal speckle patterns. (Left: Spray paint; Right: VIC Speckle Kit stamp roller)

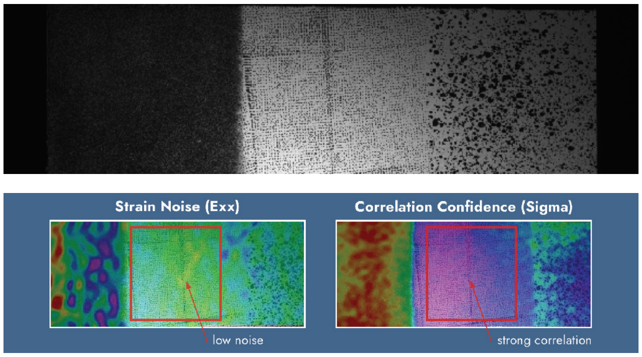


Figure 5: Shape and strain measurement data for a flat plate with different speckle patterns. The middle region was created with the speckle kit and illustrates an optimal pattern for this test, while the left and right regions are less adequate

V. Focusing

- Once your speckle pattern is applied, place your specimen in the exact testing position.
- Adjust the cameras position for the most optimal overlap and maximum pixel density on the measurement area / speckle pattern. This will maximize the measurement spatial resolution of the system. Use the "Toggle Crosshairs" button in VIC-Snap to easily identify the center of each camera's sensor. The center of the red cross should be at approximately the same location on the speckle pattern. Look for identical features in your speckle pattern to identify a common location.

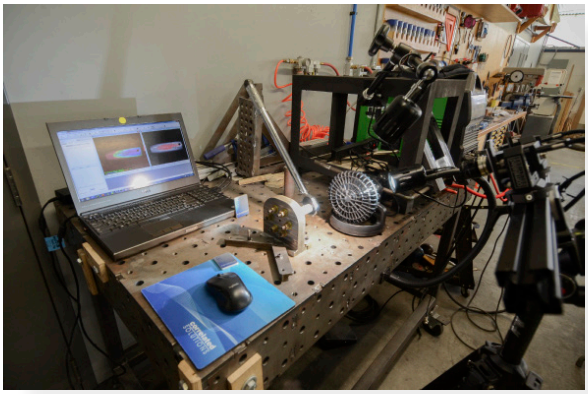
- Lock down and tighten all mounts securely. This includes all tripod and camera mounting fasteners. It is very important to have a rigid setup. The VIC-3D system's calibration (which you will perform in the next section) triangulates the cameras positions relative to one another down to a fraction of a pixel. Any large vibrations (such as an accidental 'kick' of the tripod) can cause a disturbance in the calibration. However, tightly fastening the cameras' mounts very securely will protect your calibration to the fullest.
- Using the mouse wheel in VIC-Snap to zoom in to the center of image on the speckle pattern to approximately 1100%.
- Make final focus adjustment on each camera for optimal clarity. Use human vision or electronic focus analysis in VIC-Snap.
- Tighten the collar with the 2mm Allen wrench. Look at the live image in the monitor when tightening the collar. Schneider lenses can defocus slightly upon tightening.

TIP If you tighten the collar to the point where the lens is 'snug' but you can still rotate with your hands, this will minimize the problem stated above.

- Turn on your light source.

TIP It is always best to use two or more light sources even with flat specimens. Use very oblique angles of light to eliminate any reflections in the cameras.

- Increase your exposure time to approximately 10-30ms.
- Close the aperture on the lenses until the overdriven (red) pixels just barely disappear. The aperture settings on both the lenses should be about 50-80% closed, with F-Stop from approximately 10-16. The larger the F-Stop number, the more closed the aperture and darker your image will be.
- Increase the exposure time or add more light to achieve this F-Stop range. The more closed the aperture the larger your depth of field will become. This is very important for forming or compressive applications due to the significant out-of-plane deformation that occurs.



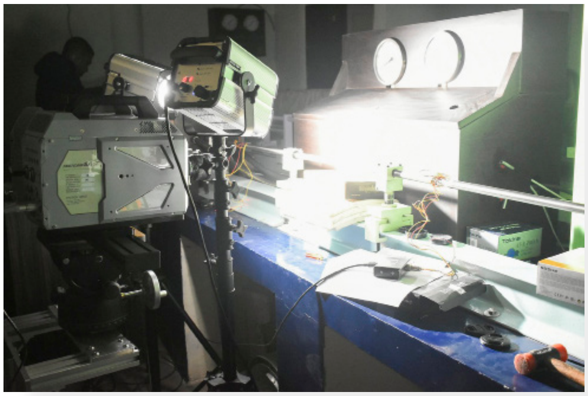
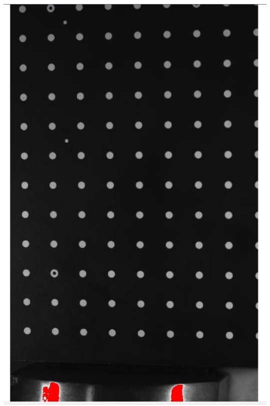


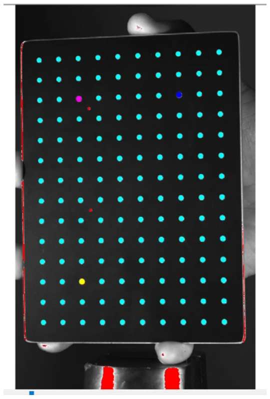
Figure 6: Examples of lighting setups

VI. VIC-3D Calibration

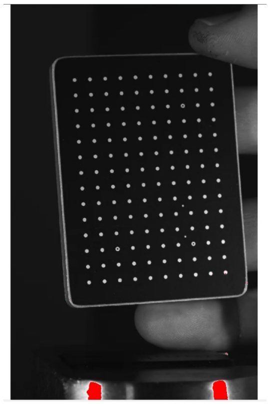
- The calibration procedure calculates variables regarding the camera geometry and imaging
- To begin, select a grid that approximately fills the field of view.



Too Large



Correct



Too Small

Figure 7: Choosing the correct target size.

- Before acquiring calibration images in VIC-Snap, enter a filename prefix for the images by clicking Edit Files in the menu or toolbar. The filename prefix and the location for saving the images are shown in the Image Prefix fields in the Project Options window as shown below. Choose an appropriate prefix such as “BendingTest1” for your speckle images, and “BendingTest1-cal”will be set for your calibration images.

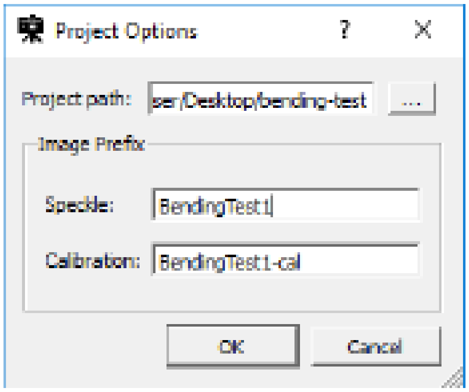


Figure 8: Selecting a name for image files.

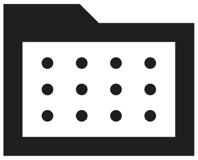
- Remove your specimen from the test area, if at all possible. It is ideal to capture images of the calibration target at approximately the same location of your specimen. Also, this is where you focused, so your calibration images will be in good focus.

TIP You may want to mark where your specimen is located with the provided Correlated Solutions permanent markers.

- To acquire calibration images, simply press the space bar on the keyboard. You will notice an image counter will begin at 0 after you acquire your first image.
- Capture several images (approximately 20-30) of the target in various orientations. It is important to capture images with large tilts, and with good focus & lighting. You may change the exposure in VIC-Snap or the lighting during the calibration process in order to achieve high contrast images of the target. Make sure to include significant rotations about all 3 axes.
- **NEVER** change the aperture or the focus of the lens during or after the calibration process. This will change the distortion parameters for which VIC-3D corrects.

TIP Use the provided wireless remote to acquire images if performing the calibration by yourself, or ask for help from someone.

- To calibrate using the acquired target images, start VIC-3D. Select Calibration images from the start page, or click Project -> Calibration images or click the Calibration Images button on the toolbar:



- Navigate to the correct folder and select all of your calibration images as shown below. Then click *Open*.
- The selected images will appear under the Calibration Images section in the Images tab.

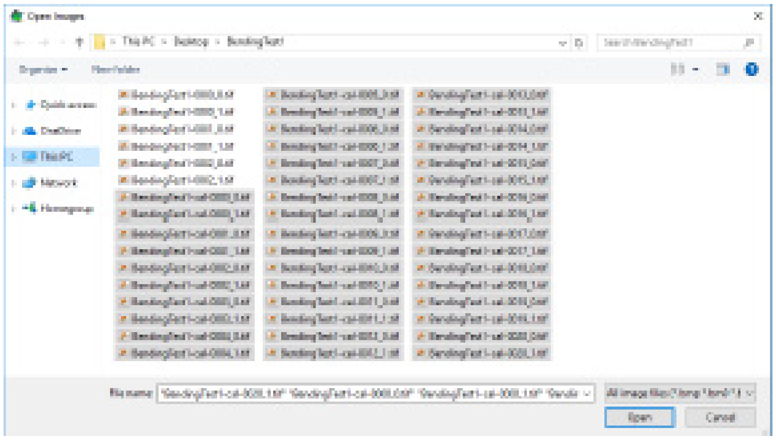
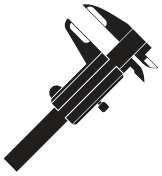


Figure 9: Windows dialog for importing calibration images

- To begin calibration, click Calibration -> Calibration stereo system or click the Calibrate button in the toolbar:



- The calibration target size will automatically be determined from the coded target. For older targets, select the size that was used (e.g., 12 x 9 - 9.0mm) on the drop-down menu at the top left-hand corner).
- Click *Analyze* to run the calibration.
- The overall error (standard deviation of residuals for all views) will be displayed in green as shown below.

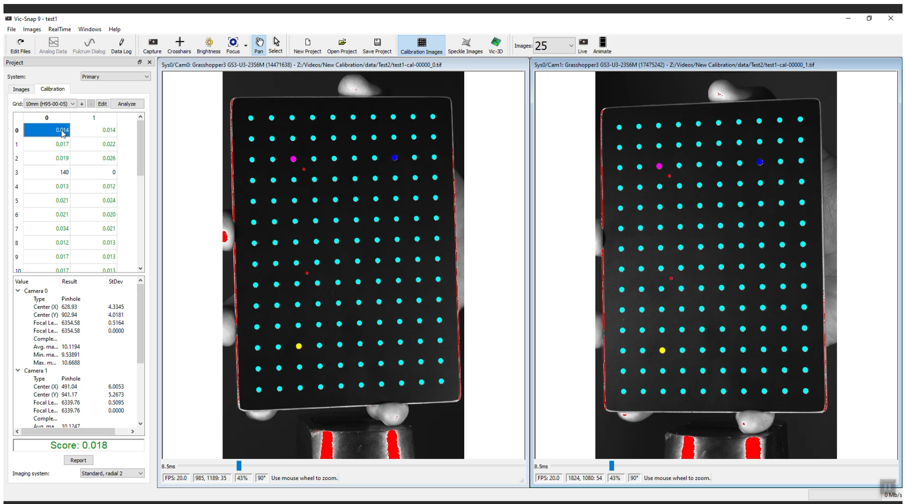


Figure 10: Analyzing accuracy of the 3D calibration.

- You can delete values that are too high by right clicking on the box and clicking *Remove*. You can use the control key on the key board to select multiple rows.

TIP There is no need to select both scores from camera 0 and 1 when removing the row. One will automatically remove the corresponding pair.

- A good score should below 0.05. An acceptable score is below 0.1. The lower the score the better. You should aim for < 0.02 for an excellent calibration. When calibrating a system with the Schneider 8 or 12mm lenses, use a distortion order of 2 or 3 (which ever gives you the lowest score). Increasing this number uses a higher distortion order that is typically needed for wide angle (short focal length) lenses.
- Click *Accept* and **save** your VIC-3D project.

TIP Now is a good time to look at your calibration parameters in VIC-3D by clicking on the calibration tab as shown below. The Beta angle is your stereo angle and the baseline is the distance between the center of each cameras sensors.

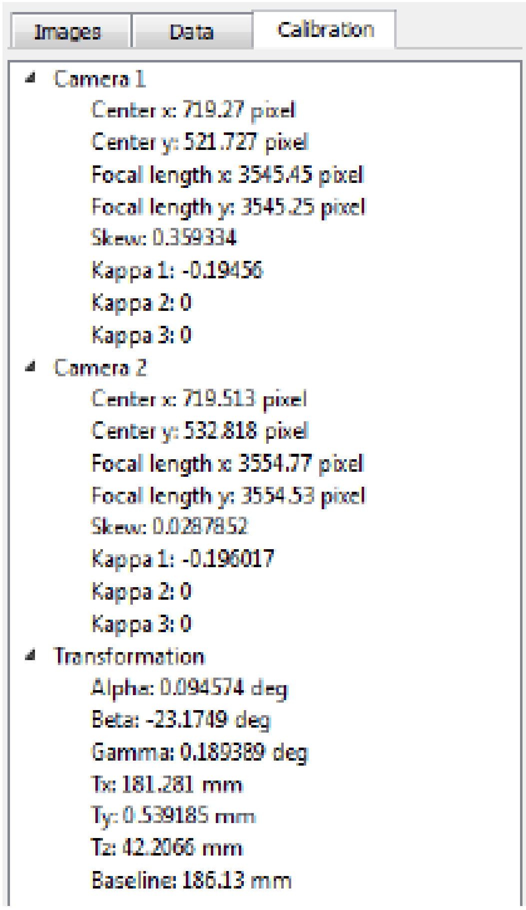


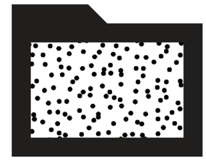
Figure 11: The VIC-3D calibration tab

VII. Post-Processing Speckle Check

Checking your speckle pattern with VIC-3D is the **BEST** way to determine what results you can expect from your test images. This procedure will help you determine what parameters you will use for your test images. It will also reveal the x, y, and z (u,v,w) displacement resolution of your setup.

- Re-insert your specimen in to the same position it was earlier (ready to test).
- Adjust the lighting and exposure time so that you have a bright high-contrast image in VIC-Snap. This can be achieved by increasing the exposure in VIC-Snap until your white area on your specimen becomes oversaturated (red), then lowering it slightly until the red disappears.
- In VIC-Snap, click *Edit Files* in the menu or toolbar to change the filename of the image you about to take. Change it to "Speckle-Check".

- Take an image with the space bar.
- Open your Vic-3D project.
- Import the image you just took by clicking Project -> Speckle images or by clicking the **Speckle Images button on the toolbar:**



- Define your AOI (Area of interest) on the speckle pattern by using the AOI tools at the top left. The polygon tool will be the most commonly used AOI tool. Make sure you do not draw your AOI (or add a polygon point) outside the speckle pattern. Use the mouse wheel and cursor to move around your image. You can always move a polygon point after you are finished. Double-click your last point.
- Click the subset size suggestion button to see what subset size VIC-3D suggests. The value will typically be higher than what you will use, because larger subsets give you lower noise, but may not be ideal for specimens with holes, complex geometry, or round edges. If VIC-3D suggests a subset size of around 31-51, then you did a great job with your speckle pattern! Click *Ok*.
- You should see an array of yellow grids on your AOI. This is your subset size (31 x 31 pixels for example).

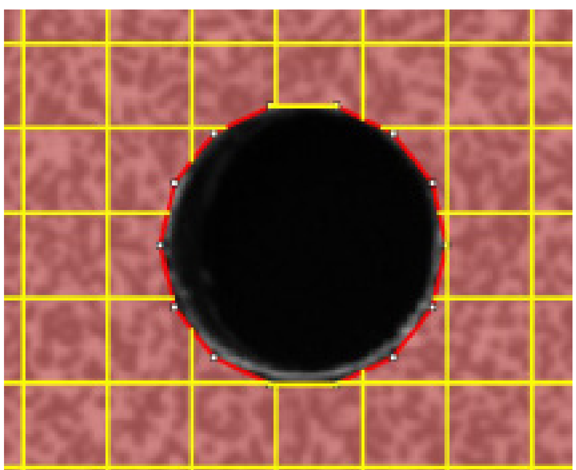
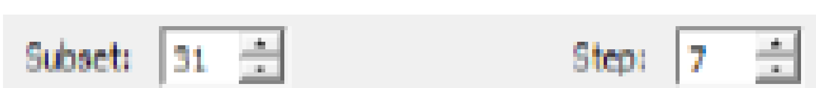


Figure 12: An AOI shown around a hole.

- If your suggested subset size is very large (>51), you can reduce the subset size at the top left as shown here:



TIP You want to adjust your subset size so that there is a good variation of black and white pixels within EVERY subset. Find your largest 'speckle' and zoom in using the mouse wheel. Make sure that your subset size is slightly larger than this feature.

For more information about your system, contact support@correlatedsolutions.com or visit the support panel at www.correlatedsolutions.com/support.

- Leave the step size as 7 for now. The step size controls the density of the data. A smaller step size will give you a larger number of data points.

- Click the *Run Analysis* button
- In the VIC-3D Analysis window, click on the Post-Processing tab and select the "Compute confidence margins" check box as shown here:

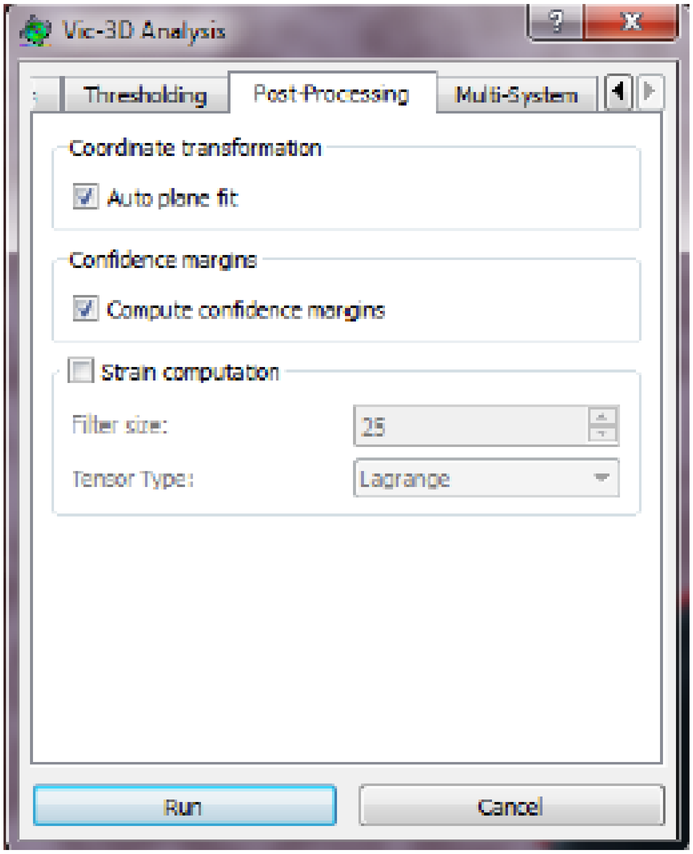


Figure 13: The VIC-3D Analysis window.

- Click *Run*.
- After your image has been processed, note the projection error. This error is a direct indication that your calibration is good or bad. If it is not red, the calibration is good. If it is red, you may need to take new calibration images.

TIP

You want to adjust your subset size so that there is a good variation of black and white pixels within EVERY subset. Find you largest 'speckle' and zoom in using the mouse wheel. Make sure that you subset size is slightly larger than this feature.

- Click *Close*.
- Double click the .out file now located in the data tab to the left.
- The 3D plot you see is a shape measurement on the surface of your AOI.
- Right-click in the plot and change your view to 2D
- Right-click again and select the contour variable to Sigma_X, Sigma_Y, and then Sigma_Z.
- These values are the measurement resolution for the test.
- Inspect the overall average of each confidence margin by right-clicking the image and select "statistics"
- The x and y average sigma values should be around the order of 1/100,000 * FOV, and the z sigma value should be about double or 1/50.000 * FOV.
- If you are satisfied with your measurement resolution, you are now ready to start acquiring test images.
- Remove the speckle test .out file by right clicking it and selecting *Remove*. Remove the speckle test image from the images tab similarly.
- Open VIC-Snap.
- Click *Edit Files*, and change our output prefix back to "BendingTest1" or something similar.
- Click on *Timed Capture*.
- Select an appropriate acquisition interval that best suits the speed of your test. A 500ms interval will acquire 2 frames per second. You cannot make the acquisition interval shorter than what your system is capable of. For example, 20ms is the lowest value possible for the 5MP cameras to achieve a sustainable software synchronization and acquisition rate.
- About 100-200 images should be taken during the test.
- Click *Start*.
- When your test is over, click *Stop*.
- Now you are ready to analyze all your test images. Please refer to the VIC-3D Testing Guide and Manual or the selection of video tutorials on our website for post-processing guidelines.

VIII. Conclusion

Following this step-by-step guide will help you achieve the best data from the VIC-3D system. It is important to use common sense when setting up the system, and to acquire good quality images to save time later. Using your human vision as first judgment of good quality images high-contrast images will save you time calibrating and post-processing. For more information about your system please refer to the VIC-3D Testing Guide and manual that came with your system. For further assistance please contact support@correlatedsolutions.com or visit our website support panel at www.correlatedsolutions.com/support.