SEM Drift Correction

Procedure Guide

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Introduction

Vic-2D includes experimental functionality to correct for both drift and geometric distortions that occur in images taken using SEMs. The correction requires both a calibration step as well as some extra requirements for image acquisition and analysis. The steps will include:

- Acquiring calibration images

- Distortion correction in Vic-2D

- Acquiring test images

- Test image analysis in Vic-2D

Before beginning

To correct for SEM drift and distortion, you must have the proper module license key. If you do not see the **Calibration… Distortion correction** main menu option, you do not have this module key.

To process SEM images, you must know the **dwell time** and **row time** for your device.

- Dwell time: the length of time that the beam samples each pixel position.
- Row time: the time required to sample each complete row of data.

You must also have a distortion calibration target which is very flat and fills the field of view for the test. This can either be the test specimen itself, or a target made with, e.g., lithography.

Acquiring calibration images

In order to calibration for drift and distortion, a calibration sequence must be acquired. It should consist of a series of image pairs with known motions in the X and Y direction. An example sequence:
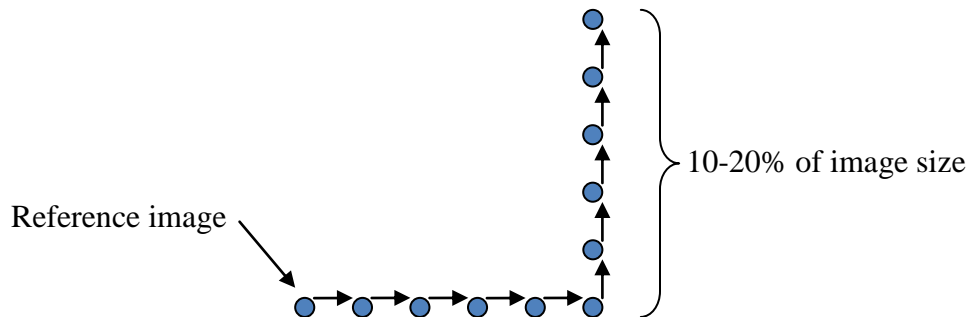
Five motion steps in **each** axis is sufficient for calibration. The **total** motion should be approximately $1/10^{th}$ to $1/5^{th}$ of the image size.

For each position, you must acquire **two** images with no motion in between, and the acquisition time of each image must be recorded. So, for the sequence above, a total of 22 images will be recorded – 11 positions with 2 images each. Also, note the **actual** displacement for each image.

Distortion correction in Vic-2D

To use the distortion sequence in Vic-2D, you will need to create a simple text file listing image file names and their acquisition time. Each line should contain a filename and a time; a sample section is shown here:

```
cropped_100.tif, 15:58:02
cropped_101.tif, 15:59:26
cropped_102.tif, 16:00:55
cropped_103.tif, 16:02:15
cropped_104.tif, 16:03:42
cropped_105.tif, 16:05:02
cropped_106.tif, 16:06:28
cropped_107.tif, 16:07:48
cropped_108.tif, 16:09:20
cropped_109.tif, 16:10:40
                    …
```
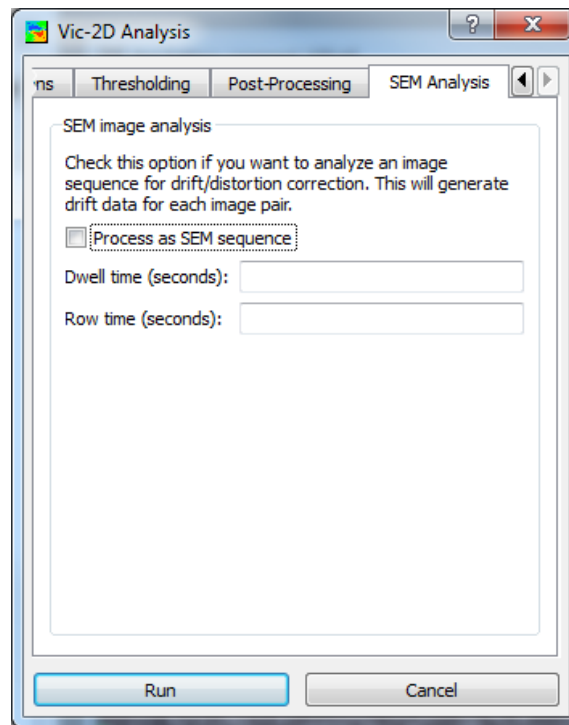
Import the list and associated files to Vic-2D by clicking **Project… Speckle image list** on the main menu. The images will be added to the speckle image list at left.
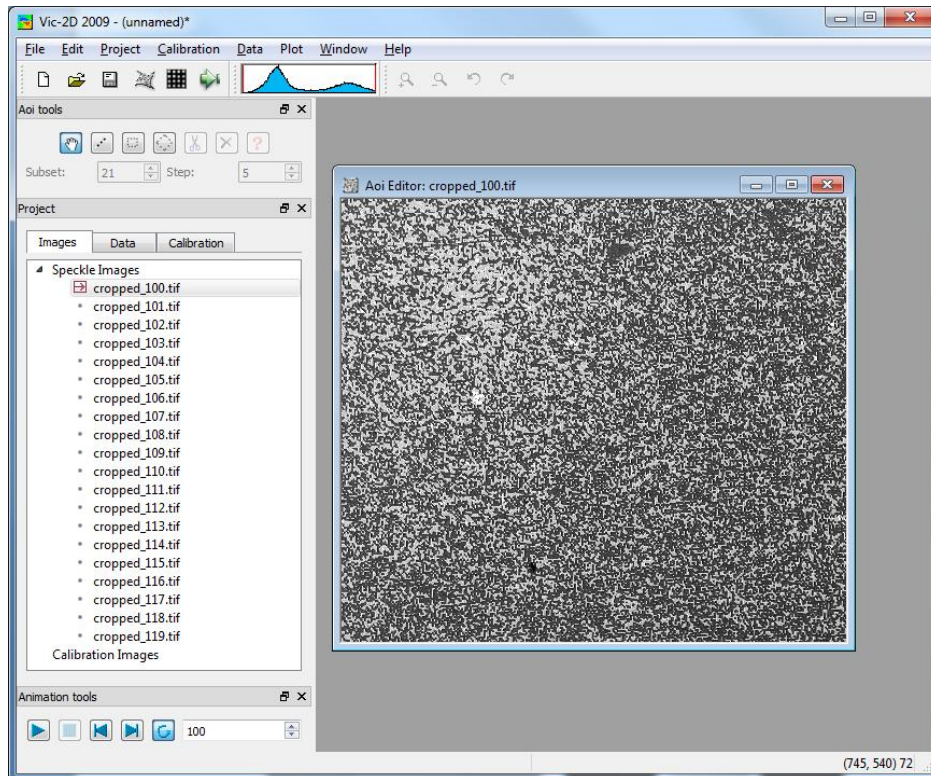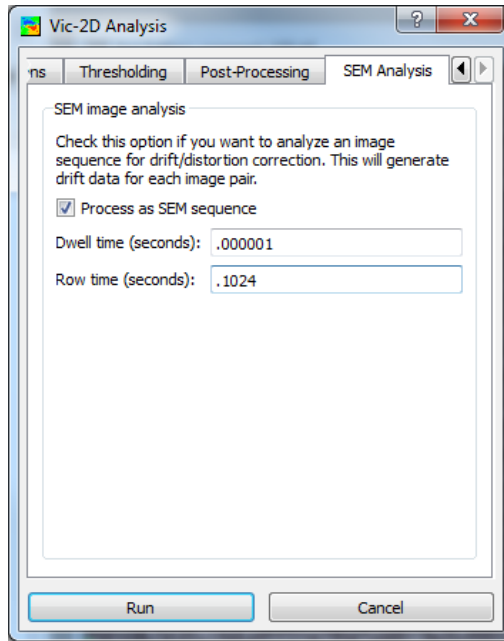
Draw an AOI which contains the full image:
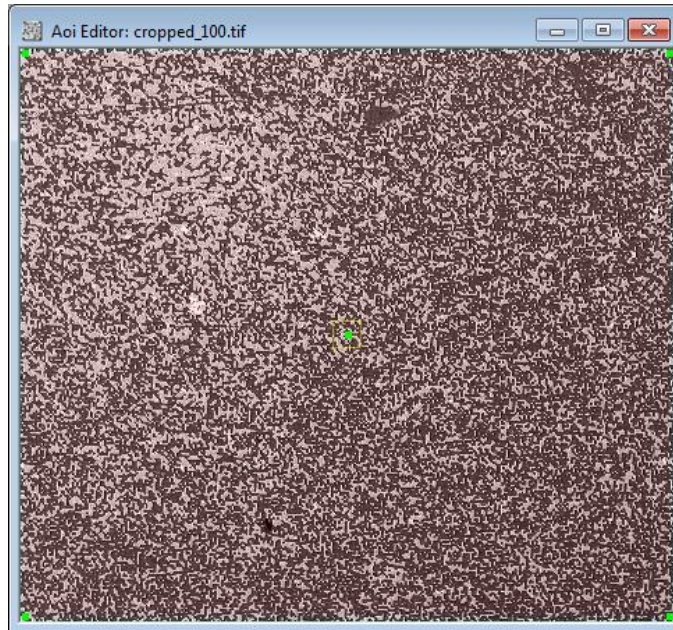
And click the **Start analysis** icon. In the Analysis dialog, click the **SEM Analysis** tab.
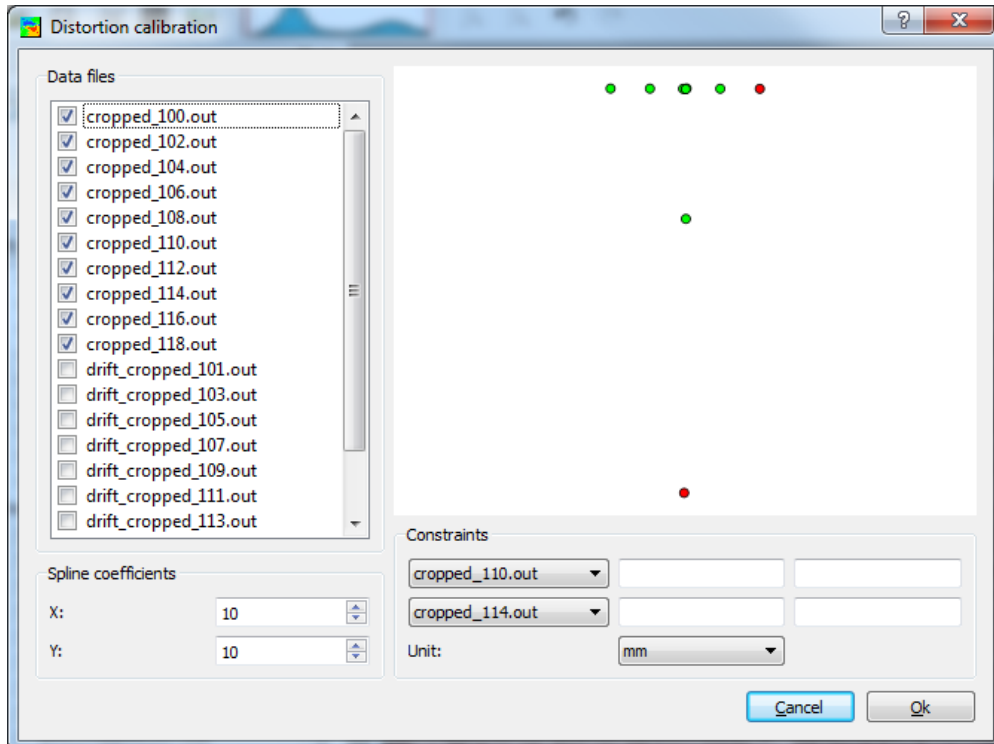

Check the **Process as SEM sequence** box. Enter the dwell time and row time, in seconds:

And click **Run**.

Once the analysis completes, click <u>**Calibration… Distortion correction**</u> from the main menu.

The dialog shows the analyzed images as well as a plot of the motions (here, a "T" shape instead of the "L" described above).

Under **Constraints**, select the two images with the **largest motion** in each axis – they will usually be automatically chosen. Here, image 110 has the largest motion in X, and image 114 has the largest motion in Y, so we leave those two images selected. (Only even images are shown as the odd images are the duplicates that must be taken.)

For each constraint image, enter the known displacement. Here, the total displacement was 0.1mm in X, and 1.2mm in Y.
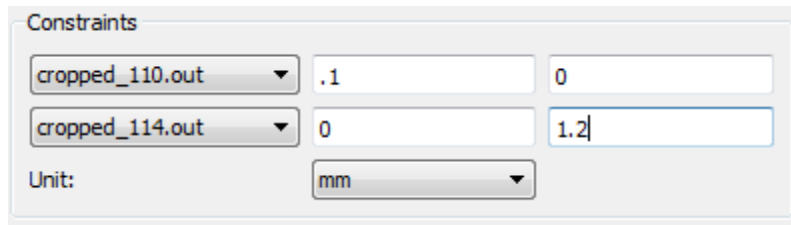

The density of the distortion map is defined by the **Spline coefficients** controls; the default is a 10x10 matrix of coefficients. This will work well for a typical SEM.

To run the analysis, click **Ok**. You will see a message indicating completion; at this point you can save the project to store the distortion correction.

If you want to check the correction, you can simply re-analyze the images you took for the distortion calibration. They should now show constant motion across the field, and low false strains.

Acquiring test images

Once you have the calibration, you can acquire the images for your test. This will proceed as normal except that, again, you must acquire **two** images at each load step, and you must note the time for each image. This is necessary to calculate and correct the time-dependent drift. You must also make an image list with times, as for the distortion sequence.

Test image analysis in Vic-2D

To begin, open the project you saved previously (if you've closed it); this contains the distortion map and drift correction information. Then, use the **Project… Speckle image list** option to import the speckle images.

Draw your AOI, and run the images as normal, making sure the **Process as SEM sequence** option is still selected and that the time values are correct. The images will contain both the raw pixel displacements *u* and *v* as well as calibrated displacements, in mm. These displacements are both calibrated for scale and corrected for distortion and drift.

Support

If you have any questions about this Application Note or any other questions, comments, or concerns about your CSI system, please feel free to contact us at support@correlatedSolutions.com or visit our web site at www.correlatedsolutions.com.