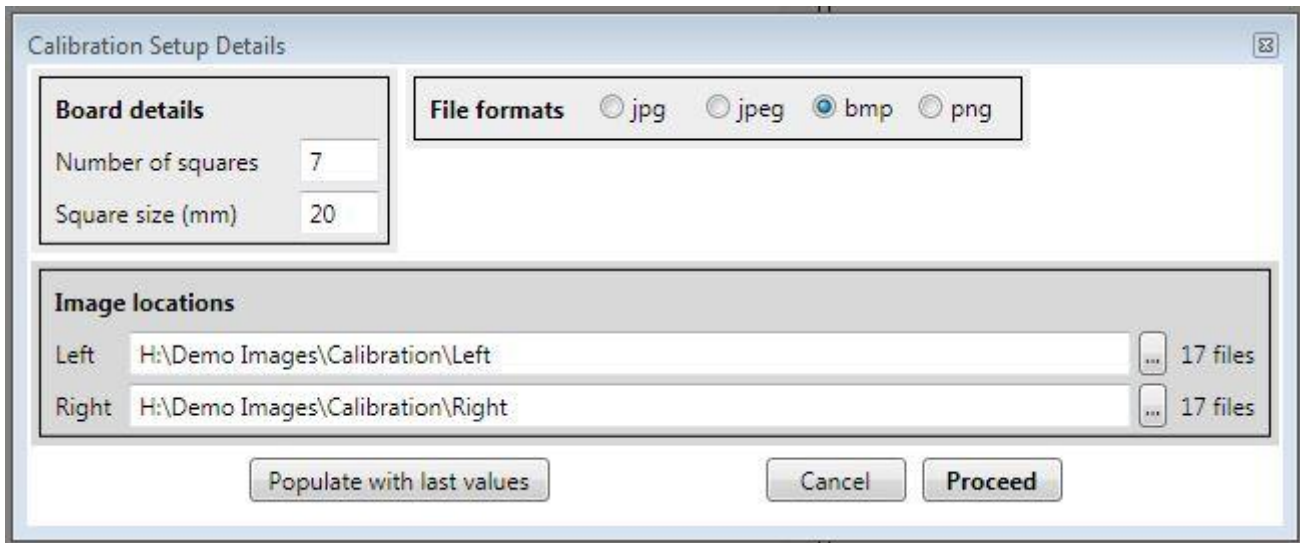


Calibration

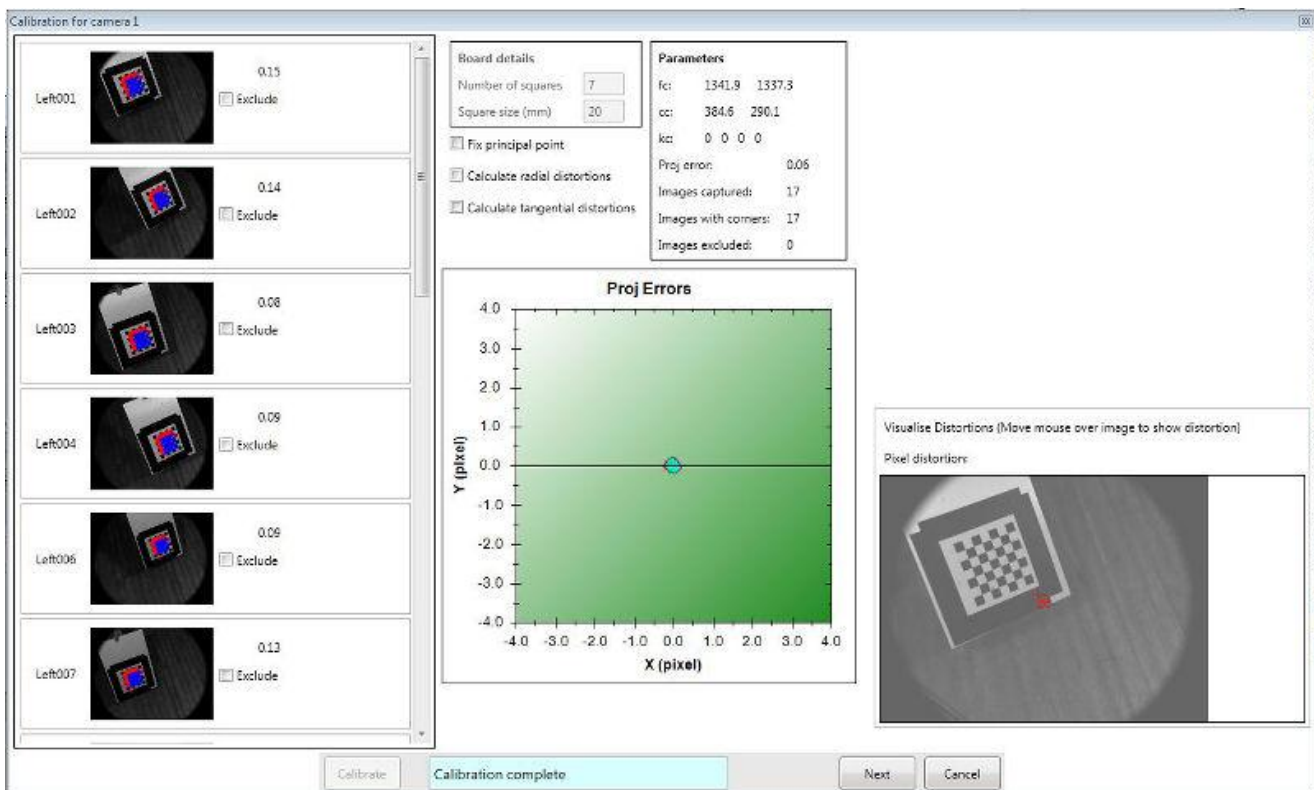
1. Individual camera calibration

The first step in any analysis is to perform a camera calibration. Select **New** in the Calibration Library.



Enter the relevant board details for your specific analysis. The values for the sample images are given in the above screenshot.

Click **Proceed** to continue.



A camera calibration window will appear. The calibration images are shown in the left hand side of the window. Click '**Calibrate**' and wait for the operation to complete (this may take over a minute if you have got a large number of images). The calibration window is shown above.

Notes:

1. If the checkerboard is not completely visible in the image then click '**Exclude**' on that image.
2. The number alongside each calibration image is the RMS pixel error for the reconstruction of the intersection points on the checkerboard. The overall projection error is shown in the 'Parameters' table. If any image has a pixel error which is considerably larger (as a guide, double the overall projection error), you should consider excluding that image.
3. The image in the bottom-right of the screen should show a circle (geometrical centre of the image) and a crosshair (calculated principal point of the camera). For most modern cameras/lenses the two points should coincide very closely. If they do not, consider selecting **Fix principal point** and running the calibration again.
4. If lens distortions are obvious, or suspected, it is worth running a calibration with **Calculate radial distortions** selected. If the overall projection error is not reduced significantly then unselect this option. Furthermore, move the mouse over the image in the bottom-right of the screen and this will display the calculated distortion (in pixels) at any point in the image. If the maximum distortion is small (as a guide, less than 2% of the image dimension) then it is advisable to unselect **Calculate radial distortions**.
5. In general, the option **Calculate tangential distortions** should not be used. This option is generally only useful if the longitudinal axis of the lens is badly aligned to the camera sensor.
6. The graph in the centre of the window shows the pixel error of each intersection point on the checkerboard.
7. To view a larger version of any image, click on it and the image will be shown in the top-right of the window.

When you are happy with the calibration, click **Next** to calibrate the right camera. Repeat the steps above for that camera.

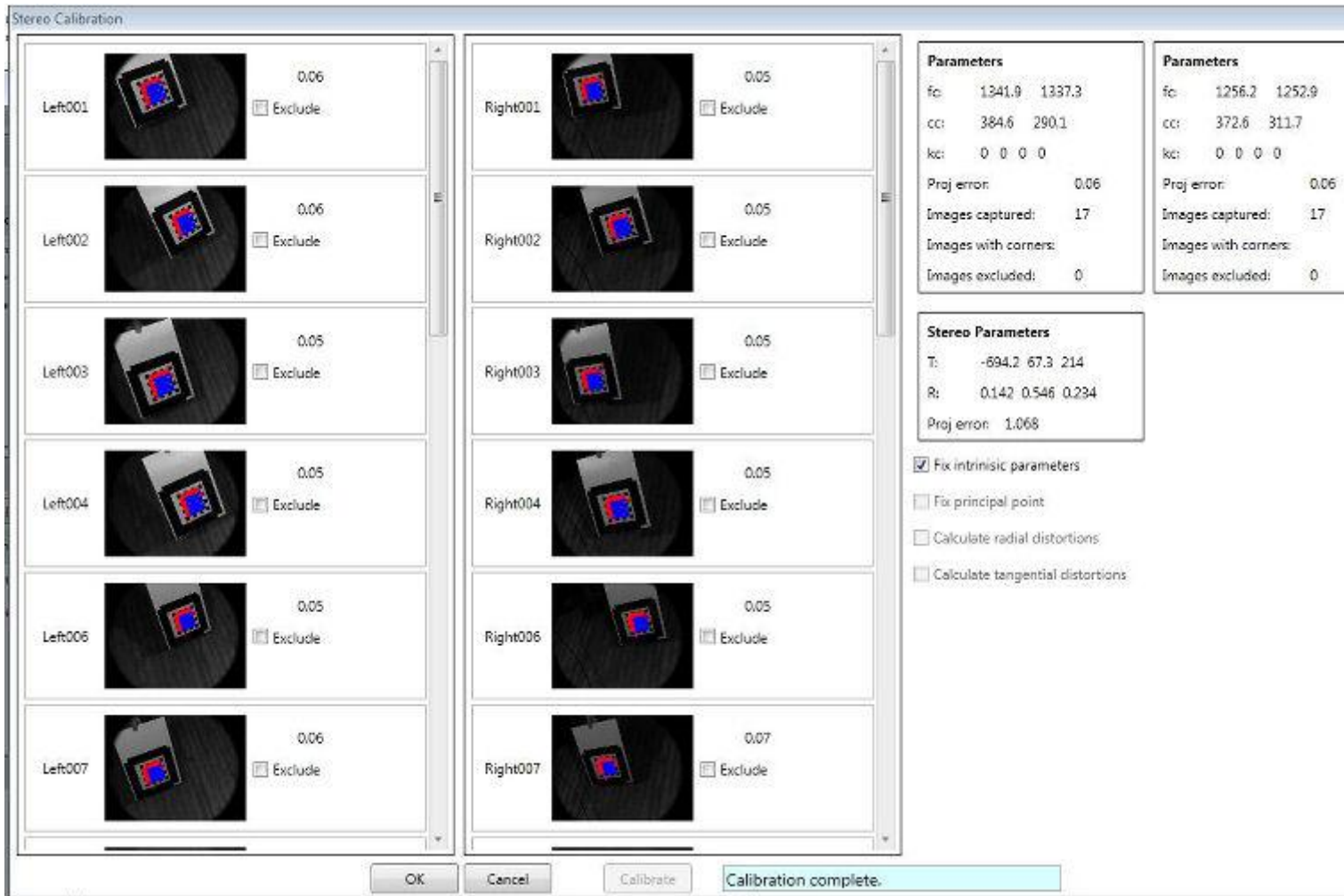
For a description of the camera parameters have a look at the [Jean-Yves Bouquet's camera calibration site](#).

2. Stereo camera calibration

On the stereo calibration window, leave the default settings and click **Calibrate**. Any excluding images from the individual calibration stage will also be excluding in this stage (along with their associated image in the other camera view).

IMPORTANT NOTE:

The pairs of images in both cameras **must be synchronised**. If they are not, the solver will either **fail (crash)** or **give the wrong stereo model**.

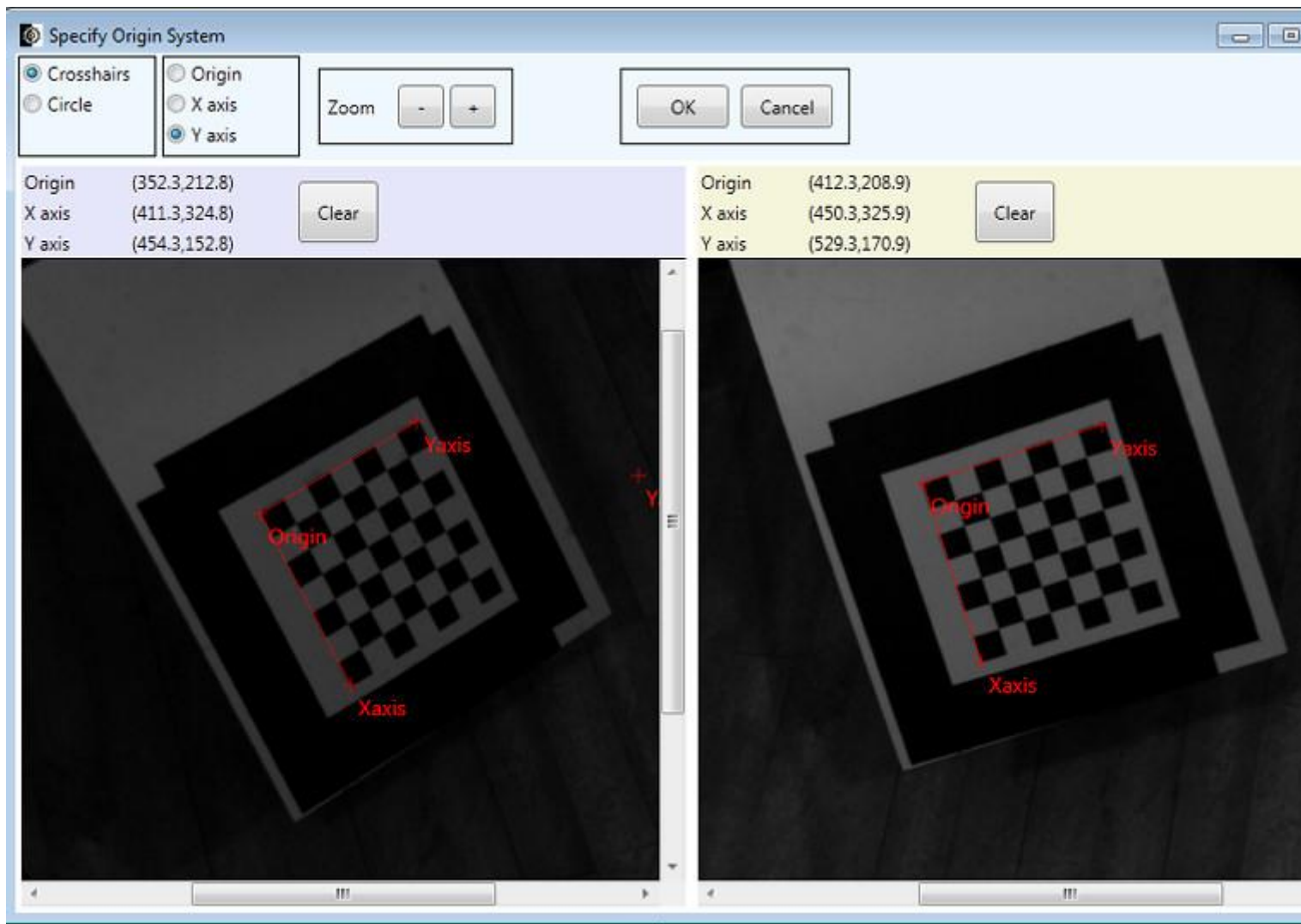


Notes:

1. The reprojection error is the RMS of the total reprojection error for all the points (see [OpenCV](#) for full description). The algorithm minimises this value to find the optimal solution.
2. If the **Fix intrinsic parameters** is selected, *Check3D* will use the same camera model as obtained in the individual calibration stage. This is the most stable method. You may wish to deselect this option. This allows the stereo calibration algorithm to recompute the intrinsic camera parameters to minimise the stereo reprojection error.

3. Specify origin system

This stage can be skipped if you do not want to specify a local origin system for the digitised data.



- To perform this step, two images (one for each camera) of an origin system must be used. This can be any suitable object, but the easiest item to use is the checkerboard.
- Drop the images onto the viewing panes (from a file explorer window).
- Click on the origin, a point on the X axis and a point on the Y axis. (**MUST BE SAME POINT IN BOTH IMAGES**)

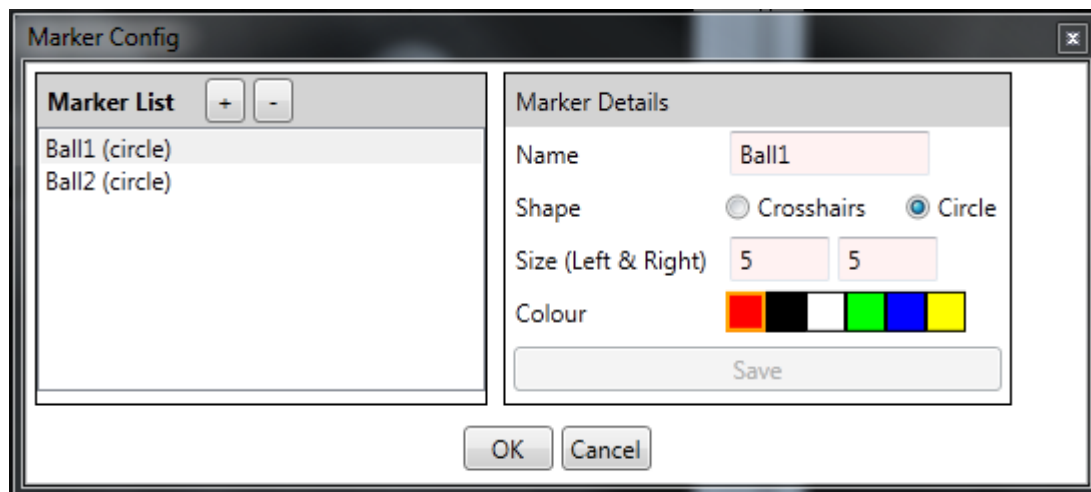
This completes the specification of the origin system, and any coordinate obtained using this calibration will be referenced to this origin. The stereo calibration file will be saved in the '..\MyDocuments\Check3D\Calibration' folder, and listed in the **Calibration Library** in *Check3D*. The uniqueID is used to identify the calibration and is the same as the filename.

Calibrations can be exported/imported so that they can be used on other computers.

Digitisation

1. Marker template

A marker template defines the number, type and size of marker to be used in the digitisation process. To create a new template, click on **New** in the **Marker Config Library**. This launches the **Marker Config** window.



Click on **+** to add a new marker, and edit the details as appropriate. For the sample images you will need two circle markers. Make them different colours but leave the default size for the left and right image as 5 (you can change this later). Remember to click **Save** to apply the changes.

Click **OK** when all markers have been defined.

2. Analysis setup

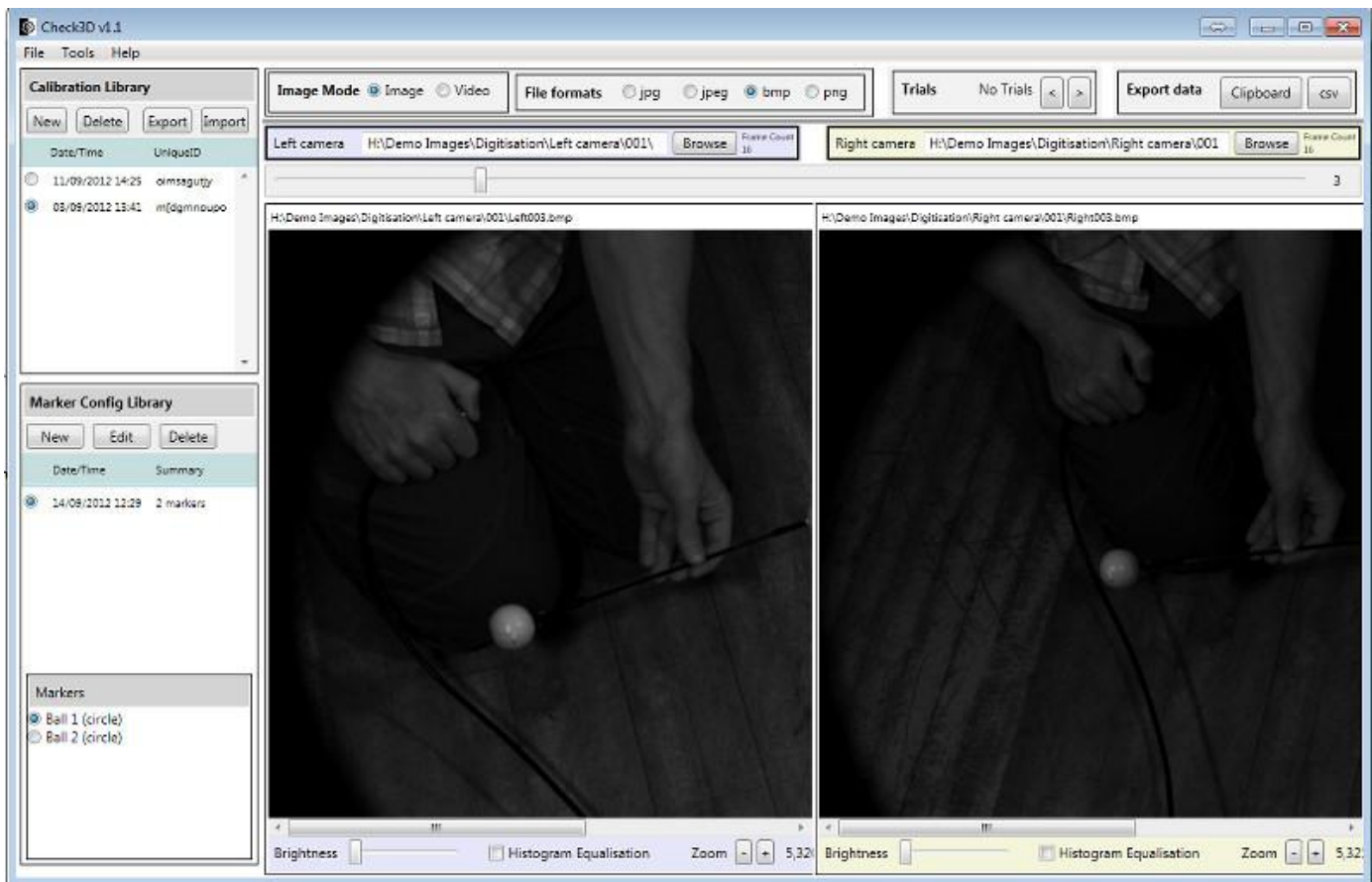
Select the relevant calibration and marker template from the **Calibration Library** and **Marker Config Library** respectively.

Select the correct file format for the images (video mode is not available in v1.0). Either:

- Browse to the left hand camera images using the **Browse** button
- Drop the folder on to the textbox next to the **Browse** button

Repeat this operation for the right camera.

The relevant folder paths for the sample images are shown in the screenshot below.



Notes:

1. For a description of the shortcut keys click **Help-Show shortcut keys**.
2. To change the size of the marker click keys **A** or **Z** (increase or decrease respectively). The marker size can be different in the left and right images.
3. To digitise a single frame:
 1. Select Ball1 marker
 2. Click on left ball in left image and left ball in right image
 3. Select Ball2 marker
 4. Click on right ball in right image and right ball in right image
4. There are two export options:
 1. Export to clipboard
 2. Export to csv - specify location of csv file
5. The export lists the XYZ position of the markers, relative to the Origin system set up in the calibration phase.
The balls should be 315 mm apart in the sample images
6. Use either the **Brightness** slider or the **Histogram Equalisation** option to enhance the images to make them easier to analyse if required.
7. The selected marker can be auto advanced by selecting **Tools-Auto advance marker** .
8. Marker names can be shown in the digitisation panel by selecting **Tools-Show marker name** .