

Trajectory calibration

Method Note MCT-036

1. Introduction

Owing to the high spatial resolution of the SkyScan 1272, a correction is needed to compensate for slight irregularity of the rotation of the sample stage. This procedure is a modified (and longer) version of the alignment test; like the alignment test it is fully automated – once the alignment pin and scanner resolution have been set up correctly.

The trajectory calibration does not need to be done as frequently as the alignment test. The alignment test can be repeated every 2-4 weeks, while the trajectory calibration should be done about every 3-6 months.

The command launching the trajectory calibration is accessible only in service mode. That means that, like the alignment test, you need to activate the service functions on the keyboard by *Shift+Alt+Control+S*. Please note that the calibration profile saved by this function will be automatically applied to all scans. Any errors in this calibration can damage the quality of all scans.

2. Method

Before this calibration is performed, the scanner should be correctly aligned by the alignment test. To run this, first place the alignment pin in the brass nut sample holder. Then go to the "Options" menu and choose "Alignment". It's best to choose the option for the full "two-position" alignment test.

Please note that for fastest operation it is recommended to perform both the alignment test and the subsequent trajectory calibration with no filter. You will use two resolution settings, the lowest (~1k) and the highest (~4k). Therefore it is a good idea to check the exposure time for both these scan modes, before starting. Just check that the mean intensity in the raw, non-flat-field corrected image, is near to 60%. Then refresh the flat fields for both scan modes.

2.1. The trajectory calibration needs a high magnification of the pin with the pin staying inside the FOV

After the alignment test, the following adjustment of the alignment pin position should be done before running the Trajectory Calibration.

With the alignment pin on the scanner stage, select the lowest resolution format (the largest pixel size with 4x4 binning, which gives 1226 pixels in 16 Mpix and 1000 pixels in 11 Mpix systems). Choose no filter. At this low resolution, select an image magnification corresponding to a pixel size of 2.5 μ m for systems with 16Mp camera or 3 μ m for systems with 11Mp camera. At this high magnification the pin will fill a large part of the width of the field of view (FOV).

Now rotate the stage to look at the pin at intervals across the whole 360 degree rotation. The projection image of the pin should stay in the camera FOV. Usually you will find that the pin image stays safely within the FOV. If it does, then no further adjustment is needed and you can move straight on to part 2.3, the launching of the trajectory calibration.

If however, the pin image – even a part of it – goes out of the side of the FOV at any part of the rotation, then go to the angle with the furthest sideways displacement of the pin. At this angle, use the lateral stage movement control (control button and left mouse button drag-and-drop in the camera image display) to move the stage so that the pin is entirely inside the FOV. You don't need to center the pin – just move it so it is safely inside the FOV.

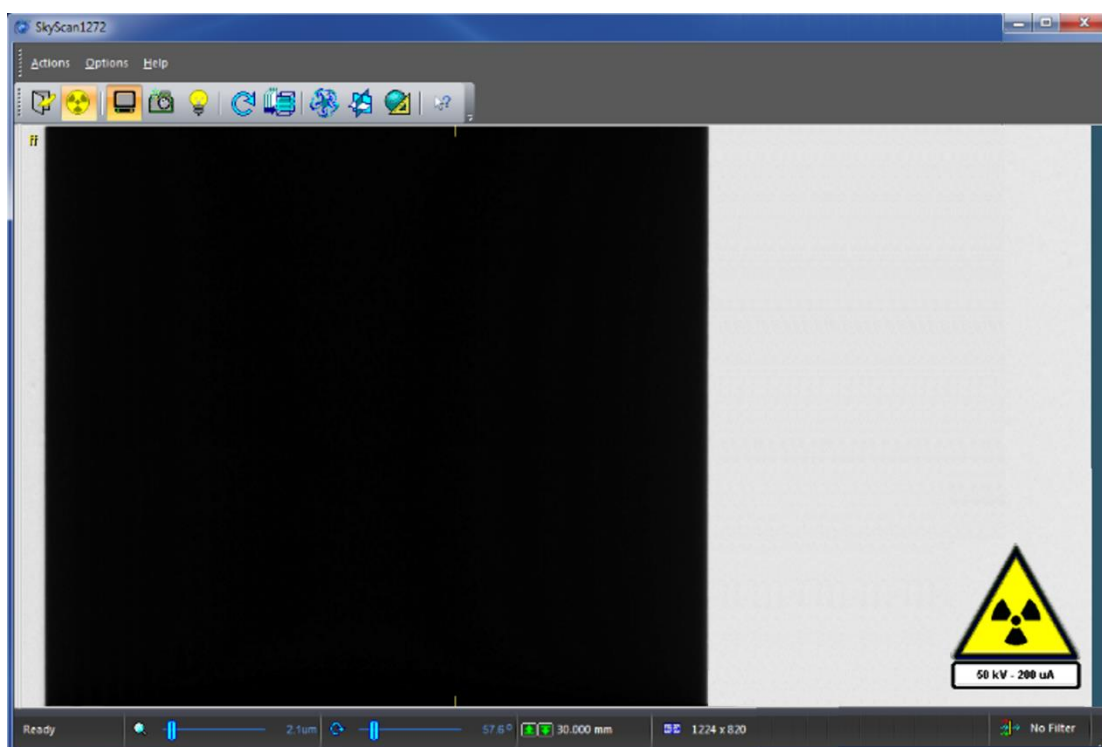
Having done this adjustment, rotate the stage by (about) 90 degrees. If the pin image is inside the camera FOV, fine. If not, then repeat the lateral stage adjustment to place the pin image inside the FOV.

The objective is that the pin moves from side to side to some extent during the stage rotation, but without going out of the FOV. So precise centering is not the goal. Note that the sideways movement is the

basis of the correction: so it is not desirable to meticulously adjust the pin position so that it hardly moves from side to side at all. This would reduce the accuracy of the trajectory calibration. The aim is that the shadow projection of the pin should move laterally during the 360-degree rotation to cover 60-90% of the width of the camera FOV – not more and not less.

This might sound complicated but in practice, 4 times out of 5, the pin position does not have to be adjusted at all to fulfil the conditions needed – as just described – for a successful trajectory calibration.

An image of the alignment pin at high magnification is shown below.



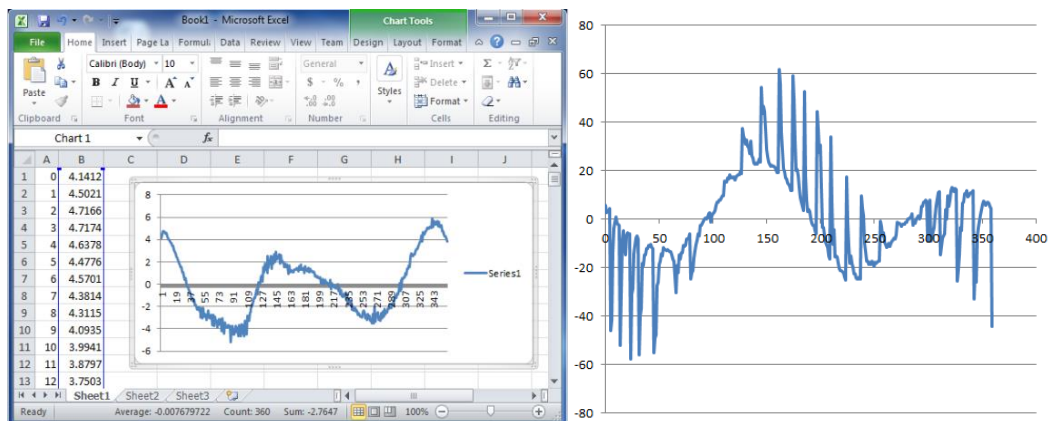
2.2. Running the trajectory calibration

After setting the correct pin position at low resolution, change the camera resolution format to highest resolution (smallest pixel size, no binning, 4904 pixels in 16 Mpix, 4000 pixels in 11 Mpix systems). Then go to "Options" and select "Trajectory Calibration" to launch the

process. After a warning message (click "yes" or "OK") it will start the calibration procedure, which takes about half an hour. No further user intervention is needed – it runs automatically like the alignment test. At the end of the calibration procedure the software will save a binary calibration file into the scanner software folder with the name "SkyScan1272CC.clb" or "SkyScan1272CW.clb" dependent on direction of rotation during scanning (selected in "Options" and "Scanner Settings").

3. Result

The software will also save a text version of the trajectory calibration curve to a file named "1272calibrationCC.log" or "1272calibrationCW.log" correspondingly. This allows you to check the quality of the calibration by opening this file in a text editor or importing it to Microsoft Excel (or equivalent spreadsheet program).



Left: A successful trajectory calibration output. Right: try again.

It is important to look at the trajectory calibration curve after performing the trajectory calibration. The trajectory calibration curve is a low frequency wave which will always have some high frequency noise fluctuation; however it should be without sharp high amplitude jumps or gaps. Any such breaks in the calibration curve indicate errors

in the calibration procedure. The image above to the left shows a normal, acceptable trajectory calibration curve, while the image to the right shows a trajectory calibration with errors, possibly caused by incorrect pin position. In this case, please repeat the test, taking care to follow the instructions above.

The trajectory calibration does not need to be done as frequently as the alignment test. Every 3-6 months is sufficient.