

Routine Calibration using silicon

Introduction

For most systems, you should do a routine calibration if the Working Distance or Camera Position are changed. Only calibrate on a known sample with a known orientation as the Si sample. The standard Si sample supplied has the orientation (001) $\langle 110 \rangle$. Align it such that the cleaved edge is parallel to the tilt axis (Figure 1).

Geometry

To index reliably an EBSD, Flamenco needs to know the EBSD geometry that is being used.

There are two main calibration parameters that change with everyday use of the microscope – Detector Distance and Working Distance (Figure 2), which affect the Projection Parameters (PP).

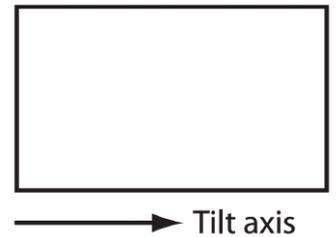


Figure 1. Schematic overview of the Si sample with the cleaved edge parallel to the tilt axis.

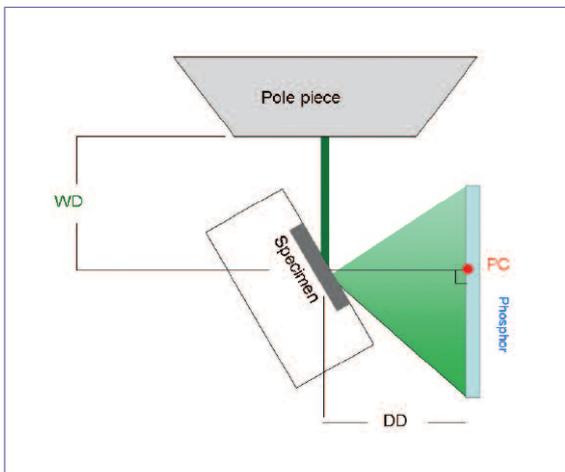


Figure 2. The EBSD originates from the point (Excitation Volume) where the electron beam hits the specimen surface.

The Detector Distance (DD) is the distance between the Excitation Volume and the EBSD detector (phosphor).

The Working Distance (WD) is defined as the distance between the specimen and the bottom of the pole piece.

The Pattern Centre (PC) is the point on the phosphor which is closest to the Excitation Volume, which changes with WD and DD. The position of the PC is shown on the EBSD (Figure 4b) with a blue cross, which is defined by PC_x and PC_y (Figure 3) in PP. The PC position is close to the (114) zone axis for an EBSD detector orientation of 0,90,0.

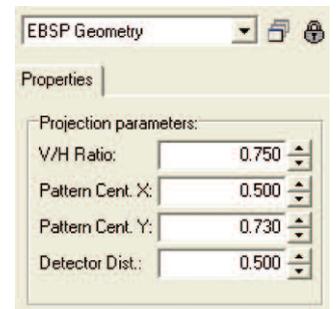


Figure 3. The Projection Parameters (PP).

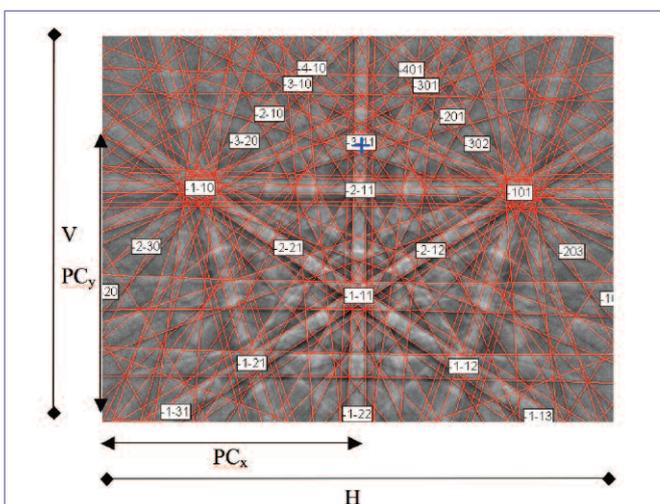


Figure 4a.

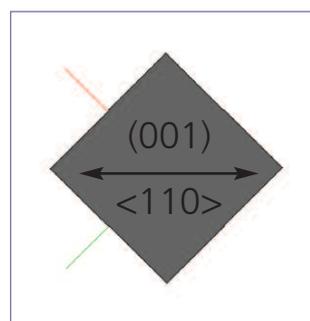


Figure 4b.

Figure 4 a and b. A good EBSD solution with the V/H ratio and the PC shown as well as the unit cell simulation.

Routine Calibration – worked example

The easiest way to demonstrate routine calibration is with a worked example. Instructions for a normal calibration are given - these will help you calibrate your system using the standard Si sample.

The procedure is as follows:

1. Align the Si sample and snap a good EBSP at high resolution (672 x 512 pixels).
2. Detect bands. Use manual band detection for increased accuracy. Mark about 6 to 7 Kikuchi bands until you have something similar to the image on the right (Figure 5).

Keep the bands well separated; avoid selecting all the bands intersecting at any point (zone-axis) and use band edges where possible. The accuracy of the calibration will depend on the precision of the selected bands.

3. Select the Silicon match unit and choose 50 reflectors.
4. Select the Projection Parameters (PP). If you do not have an appropriate calibration file either load the approximate PP values from an existing calibration file (*.cal), which was obtained at similar conditions or try and guess appropriate PP values. Or select Calibrate | Projection Parameters and enter the default values given in Figure 3. If you are unsure about the DD value, try entering 0.5 for the Detector Distance. This value may then later be refined.
5. Now index. Flamenco will now display a simulation of the EBSP in the Solution page. To check the validity of indexed result look at the labels on the 'zone axis' that they are correctly identified and the position of the bands are roughly match the EBSP. If not, then adjust the PP values to get a close enough solution.

If the EBSP cannot be indexed (indexing not possible), then adjust the position of PC and PP. If the calibration EBSP will not index, then either try reducing the number of selected bands or increase the max. number of reflectors in the match units window.

6. Refine the calibration to get the exact PP values by clicking on Calibrate | Projection Parameters. The Projection Parameters (PP) Status window will appear.

Tick on all the 3 boxes to the left and then click "Refine" and check the new projection parameters and check to see whether the simulated EBSP fits more closely to the real EBSP.

The exact PP values are achieved if the indexed solution is a perfect fit to the EBSP as shown in the image above and the MAD value is below 0.5.

7. Set the Detector (Phosphor) Orientation. Open up the Detector Orientation edit box by choosing **Calibration | Detector Orientation...** (Figure 6)

Click refine and choose silicon and enter the known orientation. Click okay.

8. Finally save the calibration into a calibration file (WD_DD.cal) to Calibration|Projection parameters.

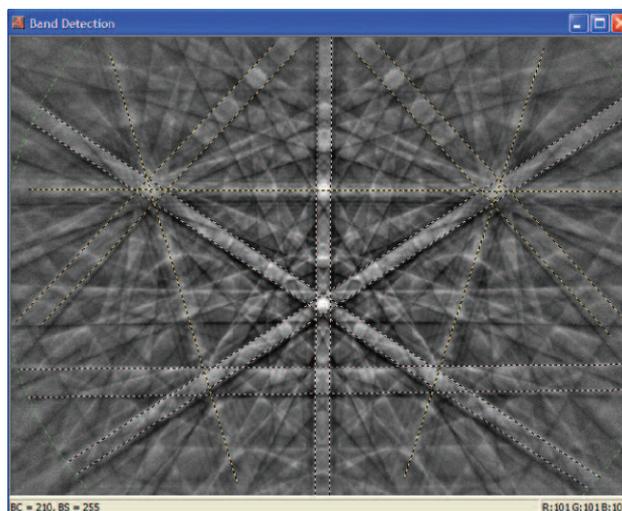


Figure 5. Band detection.

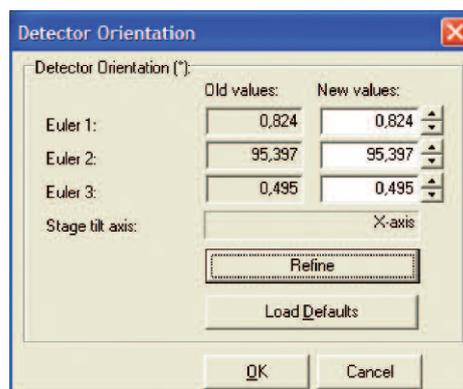


Figure 6. The Detector Orientation window.

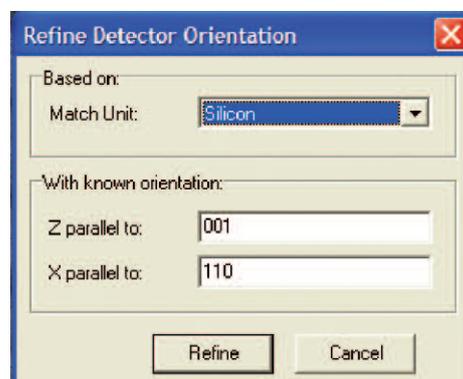


Figure 7. Refine Detector Orientation.