

---

CX Camera Series

# CX Calibration



Version: 1.4

Issue Date: July 2014

Copyright AT-Automation Technology GmbH © 2014

[www.AutomationTechnology.de](http://www.AutomationTechnology.de)



# Table Of Contents

<b>Table Of Contents</b>	<b>iii</b>
<b>Introduction</b>	<b>5</b>
Calibration.....	5
Full scanning calibration .....	6
Single-shot calibration (static) .....	7
Example of full scanning calibration.....	9
Example of single-shot calibration (static) .....	10
<b>Service Information</b>	<b>19</b>
Document Revision .....	19
Product Information and Updates .....	20

© 2014 Automation Technology GmbH.

All rights reserved. No part of this document shall be reproduced, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise without consent in writing from the owners, AT-Automation Technology GmbH.

### **Disclaimer**

While care has been exercised in the preparation of this document to ensure that it is fully correct and comprehensive, the owners assume no responsibility for errors or omissions. Neither is any liability assumed for damages resulting from the use of the information contained herein. No license is granted under any patents or patent right of AT – Automation Technology GmbH.

### **Trademarks**

All nationally and internationally recognized trademarks and tradenames are hereby acknowledged. This document is subject to change without notification. All rights reserved.

# Introduction

This document describes the calibration of a triangulation system with the CX camera (C2, C3, C4).

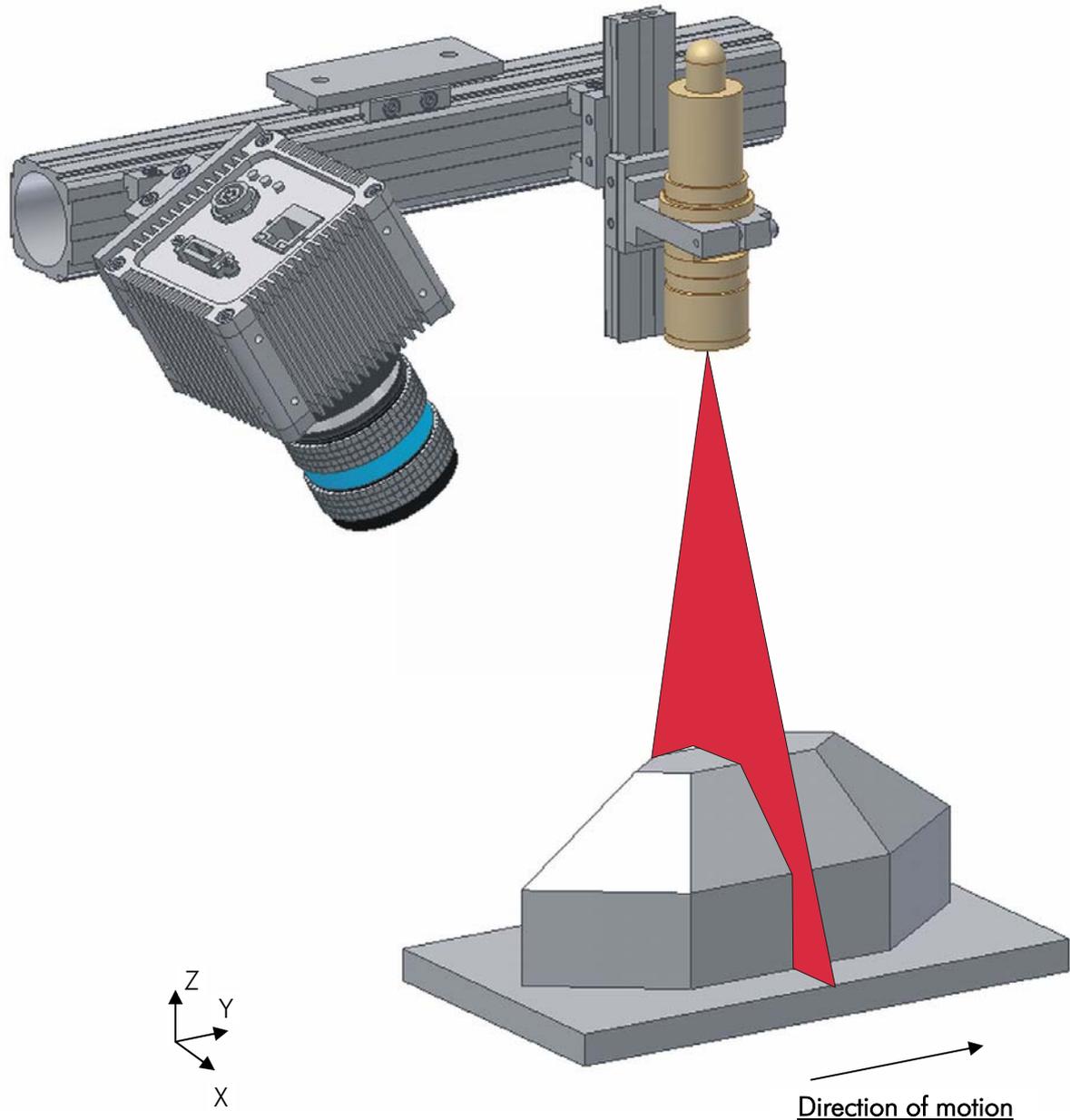
---

## Calibration

Using the integrated FPGA processor, the 3D camera extracts the profile of laser line from the sensor image with high precision and at high speed. The data of the height profile are sensor coordinates. Depending on configuration they refer either to the first row of the defined Area Of Interest (AOI) or to the first row of sensor chip (absolute coordinates). In most cases, in order to perform inspection tasks and process the height data, it is required to convert the camera coordinates into real world units. This can be achieved by using the calibration software of the camera. There are two methods to calibrate a triangulation setup with the CX camera (C2, C3, C4):

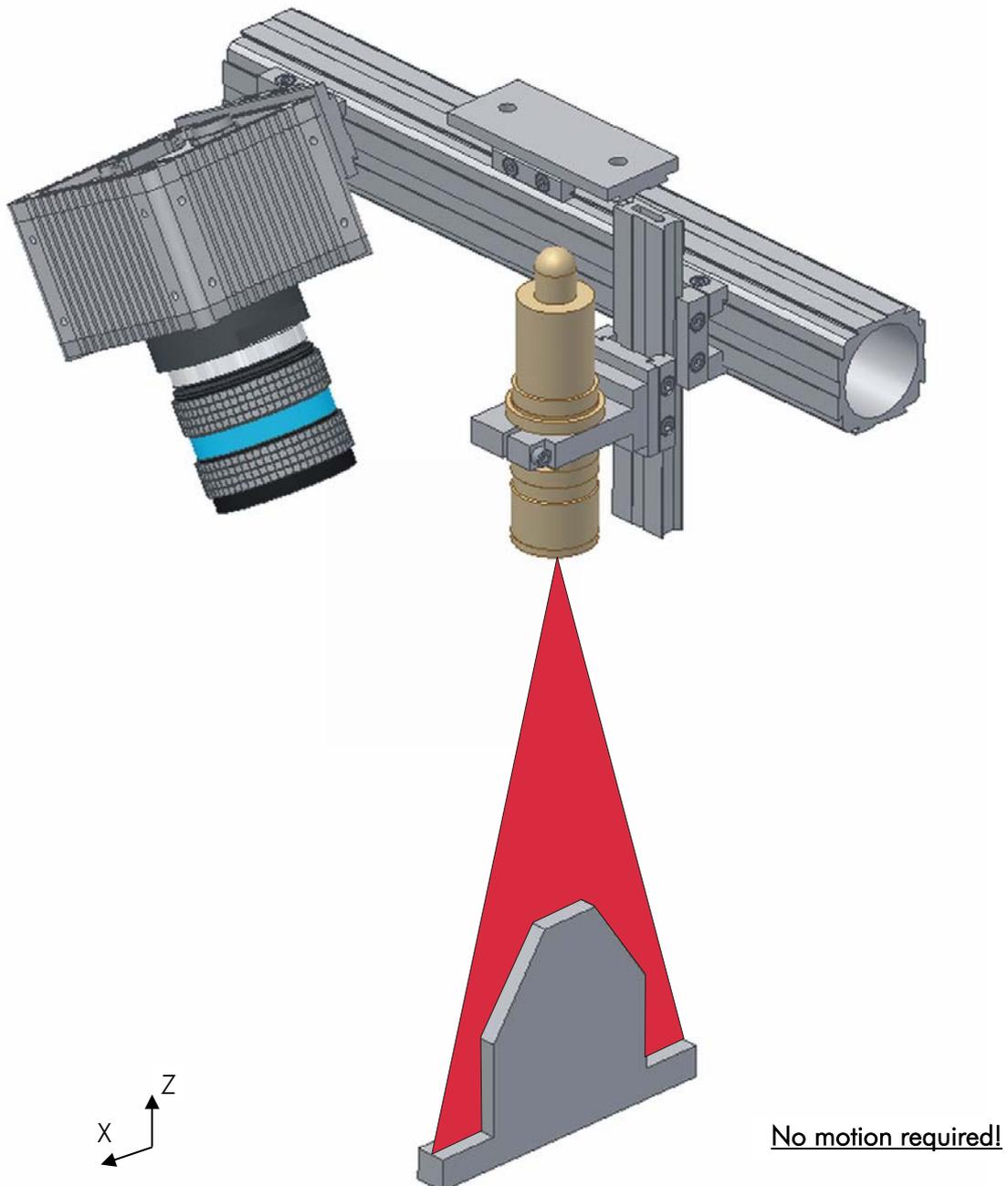
## Full scanning calibration

The method is used to calibrate the triangulation system in all 3 dimensions (X, Y and Z) and it requires the scan of a diamond shaped calibration pattern. It automatically identifies the triangulation setup and the relative orientations between camera and laser and thus it is recommended for all triangulations geometries.

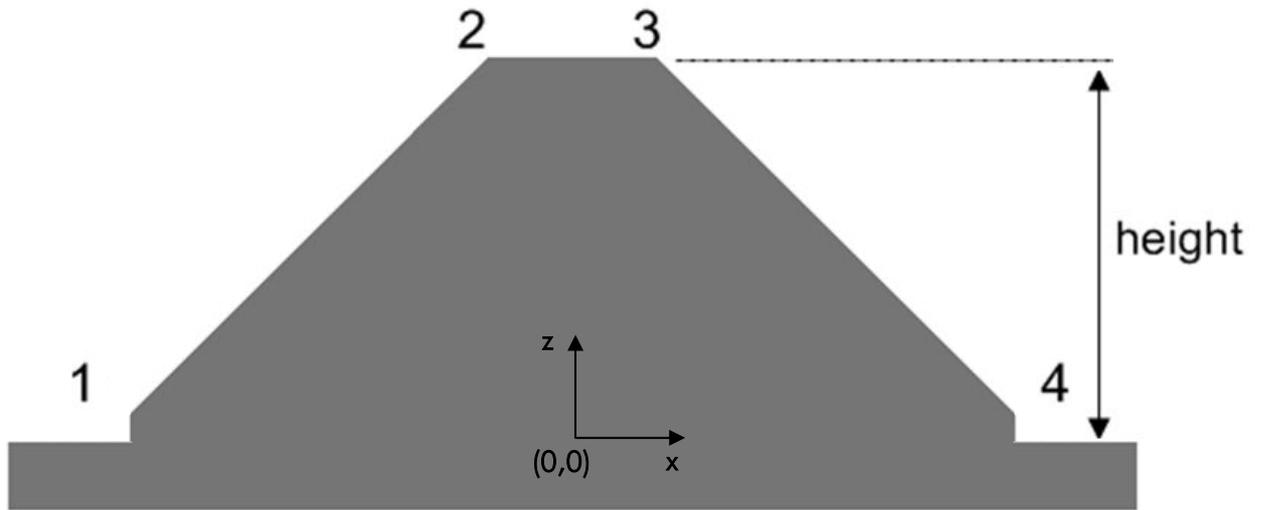


## Single-shot calibration (static)

This calibration method is used to calibrate the triangulation system in the lateral and vertical directions ( $X$  and  $Z$ ). It requires only one single image of the laser line projected on a calibration pattern. It can be applied only by the standard triangulation setup, where the sheet-of-light is perpendicular to the target surface. The advantage of this method is that no motion is required and the calibration pattern has a simple shape.



Example of calibration pattern used in single-shot calibration:



The numbered points of the calibration pattern and the height define the reference geometry to be used by the calibration process. These data must be saved in an ASCII file with the following format:

*P1x P1z*

*P2x P2z*

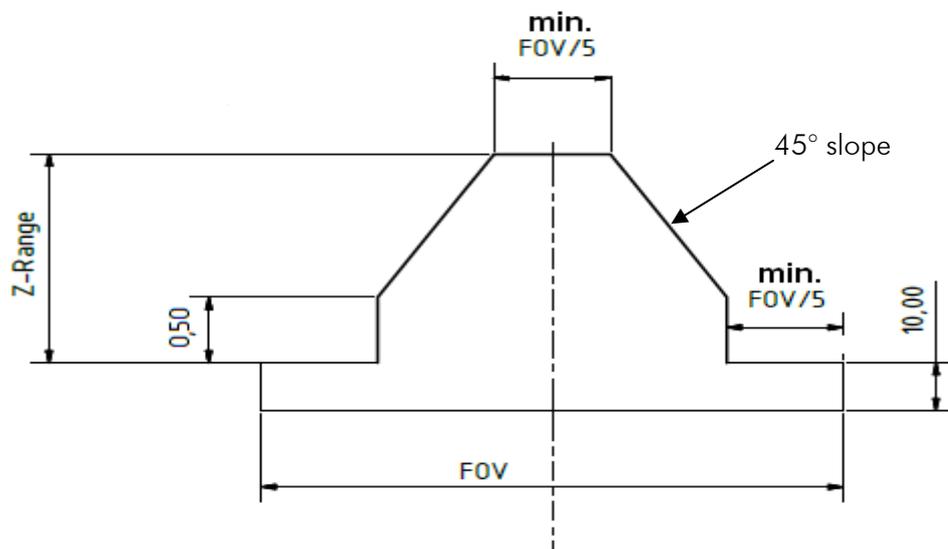
*P3x P3z*

*P4x P4z*

*Height*

where  $P_x$  is the x coordinate and  $P_z$  is the z coordinate

The geometry should be designed according to the following general scheme (units in mm):



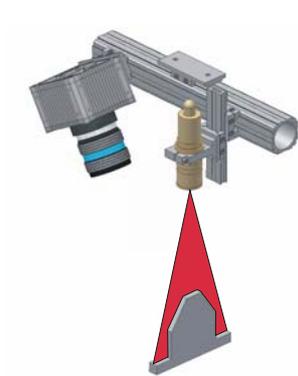
---

## Example of full scanning calibration

Under work...

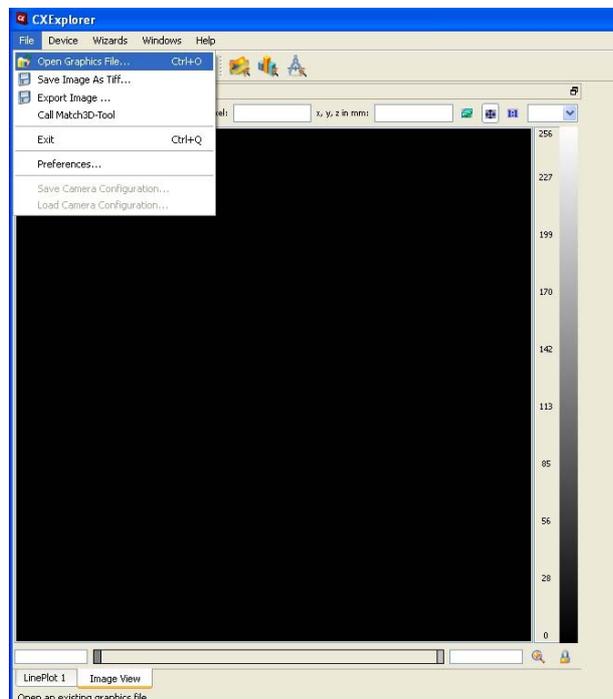
---

## Example of single-shot calibration (static)

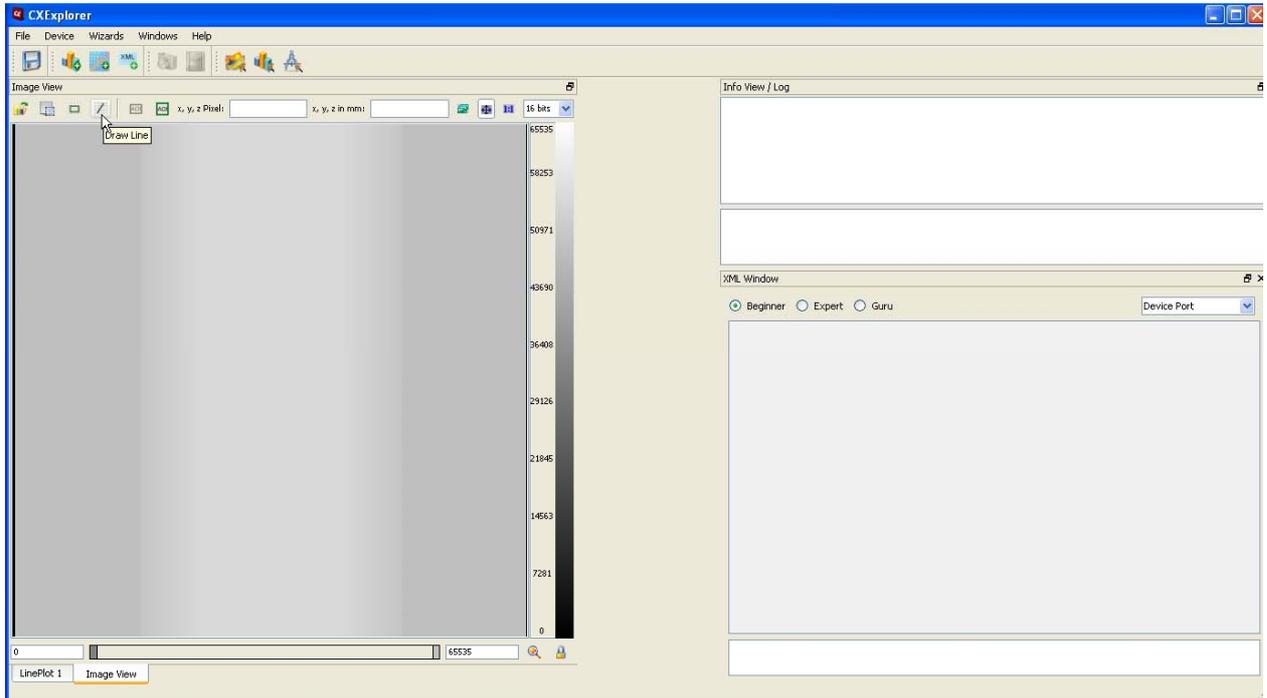


Setup the triangulation system to scan the height profile of the calibration pattern. Place the calibration pattern parallel to the laser line as shown in the figure. Be sure that the reference nodes are shown in the camera image correctly e.g. Node 1 should appear on the left side and Node 4 should appear on the right of the camera image. Using the CX-Explorer, set the camera in 3D mode and grab a height image. Adjust the integration time in order to minimize the disturbances and acquire a smooth scan.

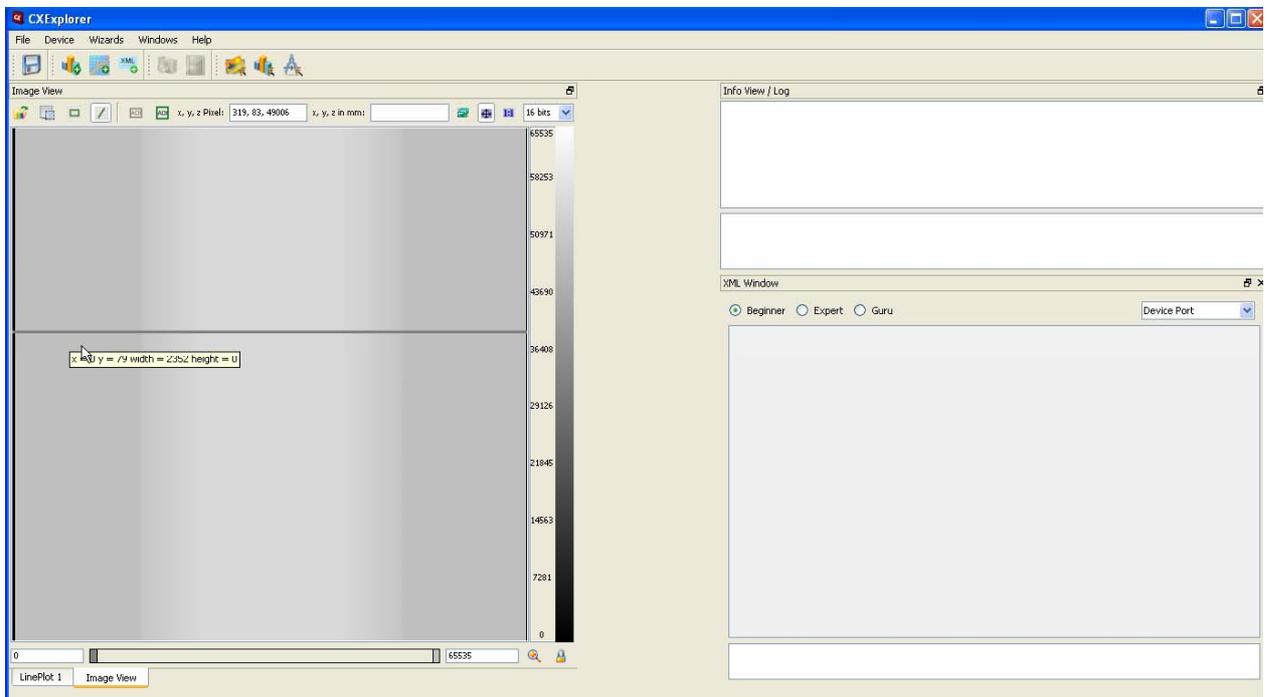
Alternatively, a previously saved height image of the calibration pattern can be loaded over menu "File" → "Open Graphics File...".



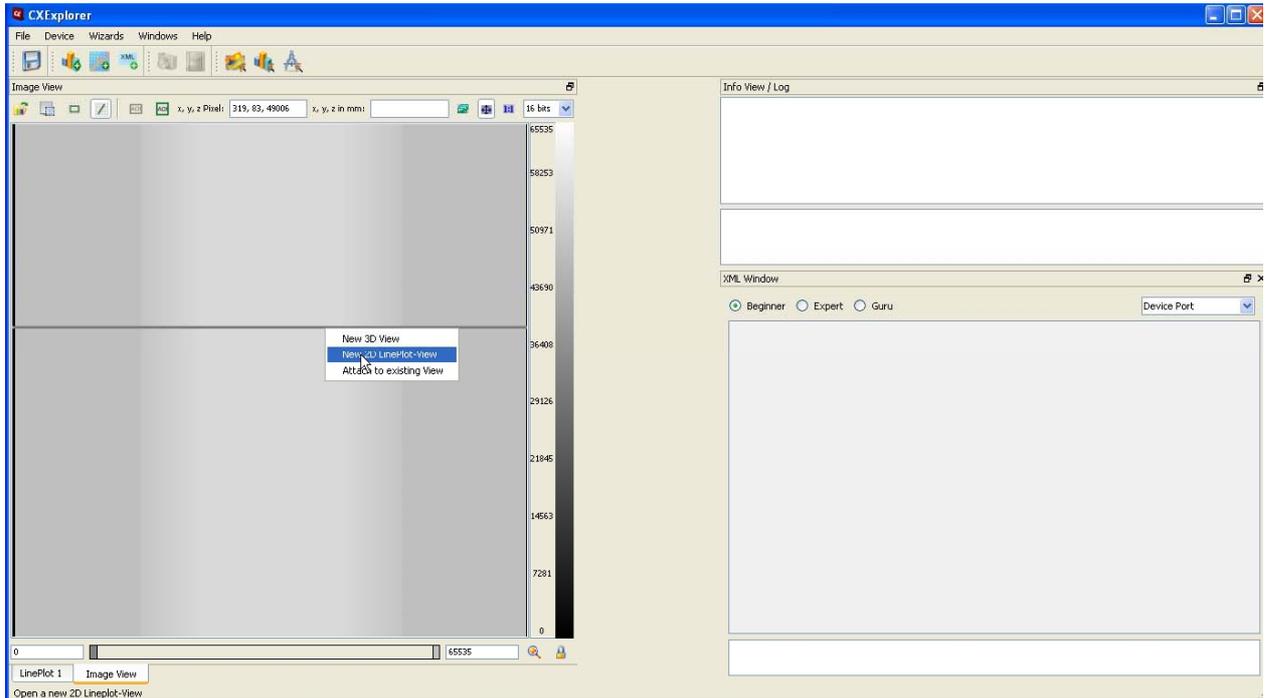
Create a "LinePlot" graph of the acquired height profile by clicking on the "Line" symbol:



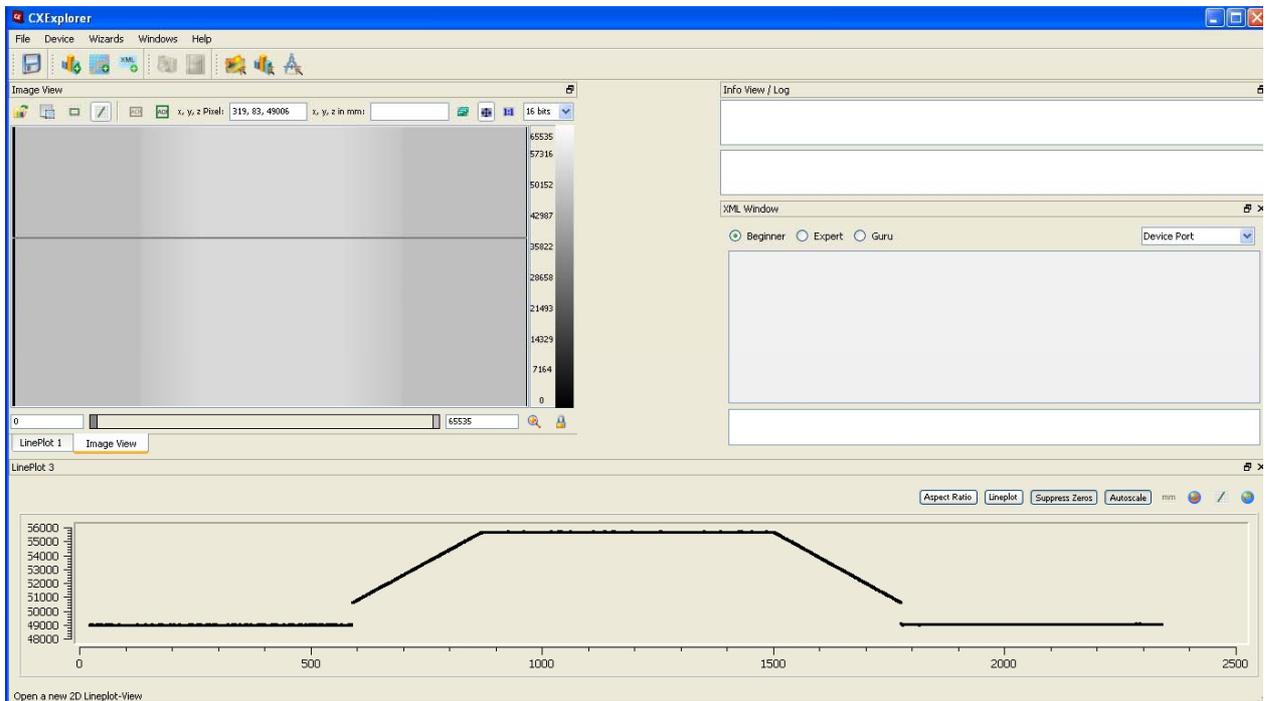
.. then drag a line across the height image by holding CTRL+SHIFT:



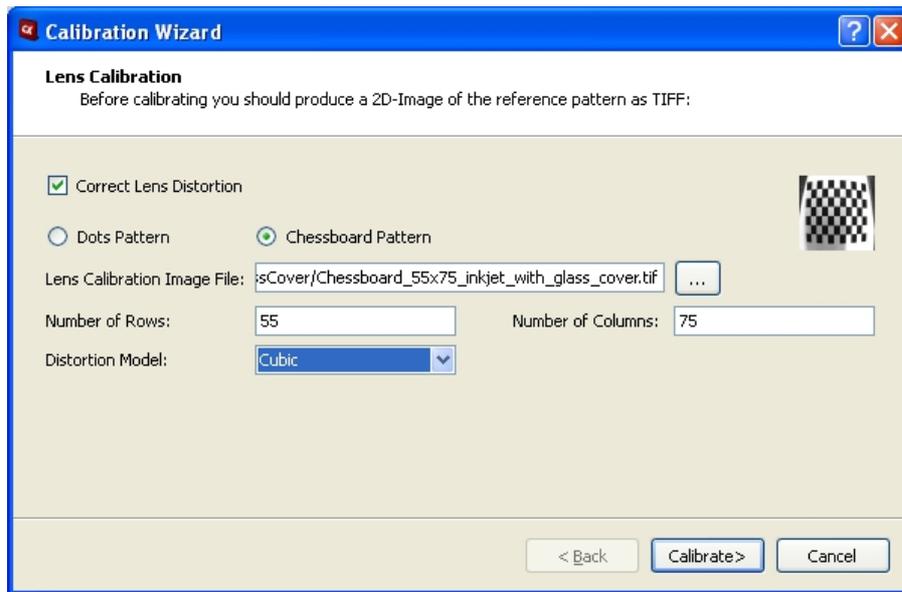
... and right click with the mouse on the line and select "New 2D LinePlot View":



The new LinePlot graph appears displaying the height data along the line selection.

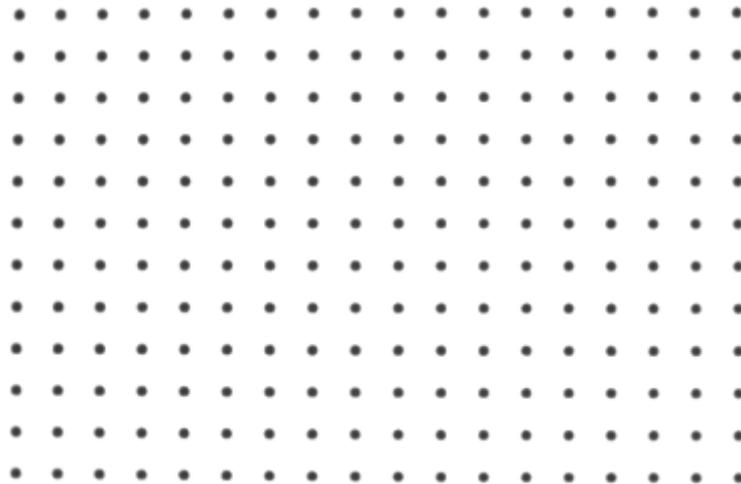


Select menu “Wizards” → “Calibration Wizard...”

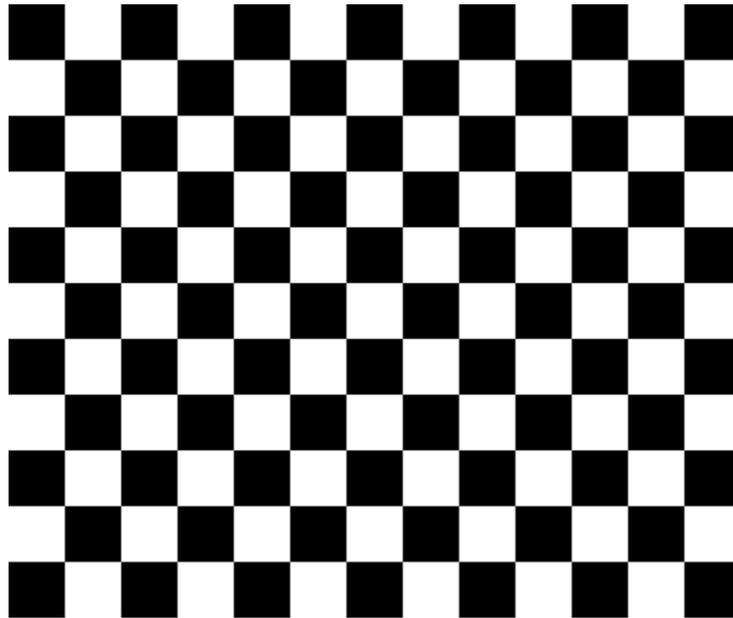


If needed, check “Correct Lens Distortion” in order to perform additional lens calibration. The method is based on the 2D image of a dot or chessboard pattern. To proceed, select the type of lens calibration pattern and enter the path to the corresponding image file (8-bit format) or click  to select it.

Example of dot pattern:

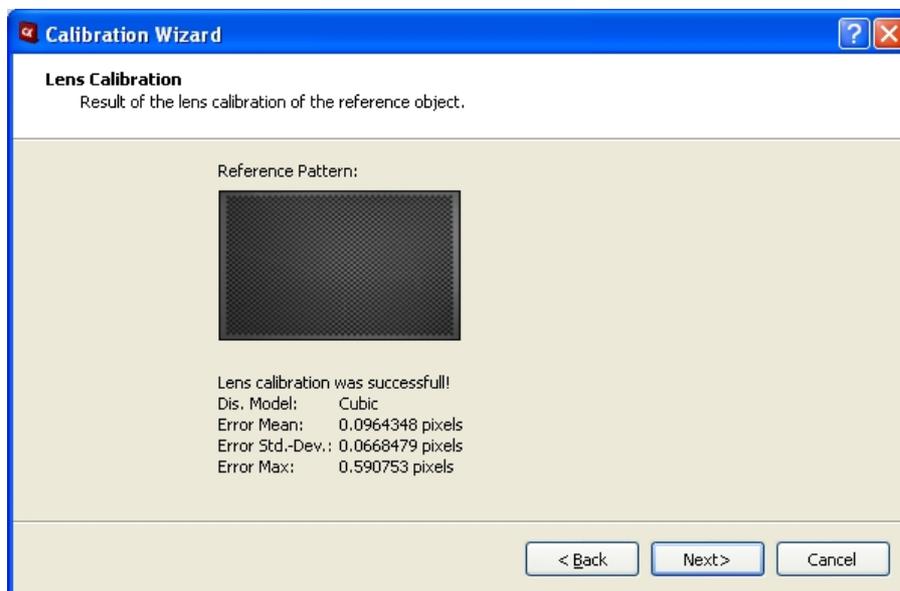


Example of chessboard pattern:

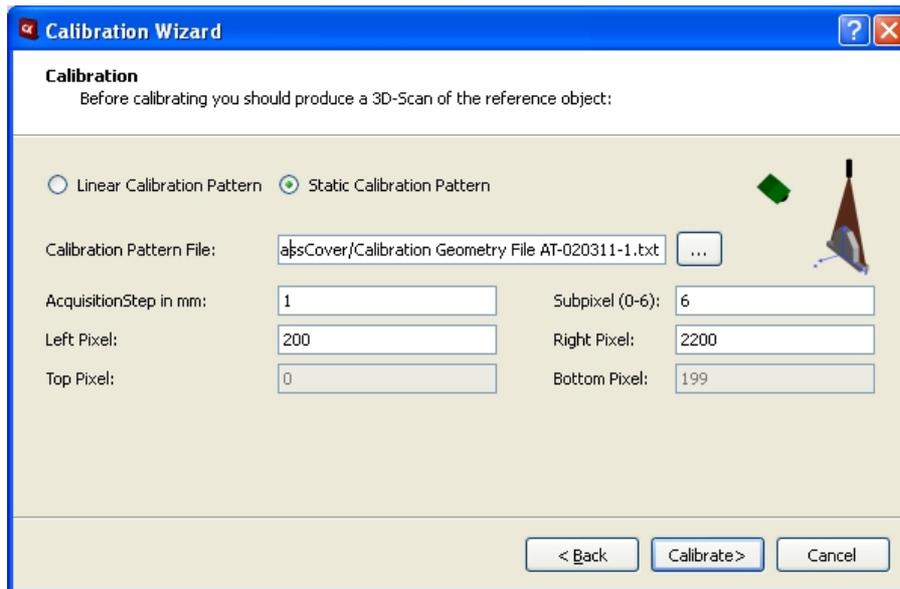


The pattern should cover the complete sensor area and feature a white border. The distance between the dots or the size of the chessboard cells should be 30 pixels.

Furthermore, the number of rows and columns of the lens calibration image must be entered, as well as the calibration model ("Tsai" standard model or "Cubic" enhanced). After finishing configuration click on "Calibrate" to proceed. The lens calibration results appear:



Click "Next" to proceed to metric calibration.



Click the radio button “Static Calibration Pattern”. Enter the path and filename of the calibration geometry file or click  to select it.

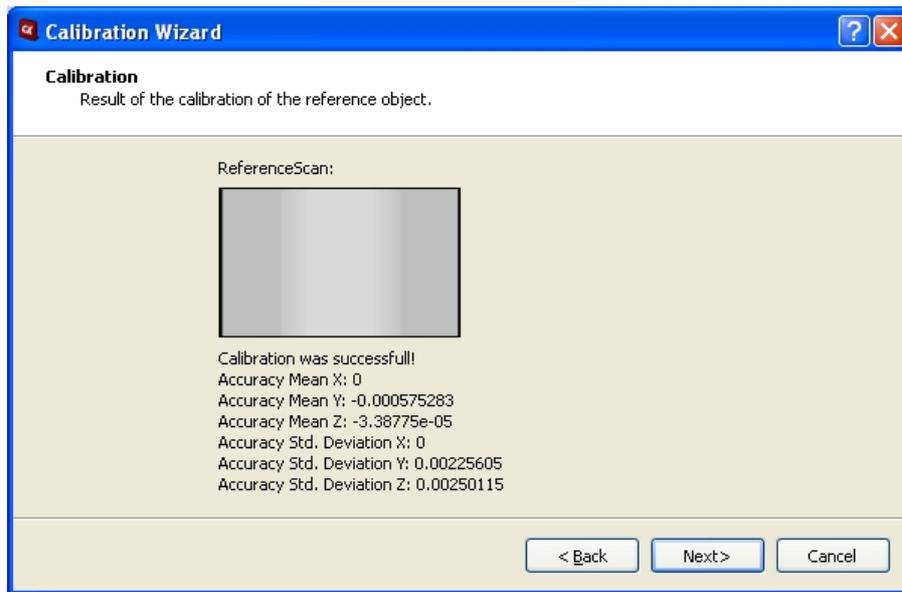
Since the single-shot calibration is performed only in the x and z dimensions, it is necessary to define the distance between two subsequent profile scans in the y direction. Enter that distance in the “AcquisitionStep” text box.

Define the x coordinates of the height profile, which limit the calibration geometry (“Left Pixel”, “Right Pixel”). Consult the LinePlot graph of the height profile. For example, in the above shown case “Left Pixel”=200 and “Right Pixel”=2200.

If a lens calibration has been performed in the previous step, the number of subpixel bits must be entered.

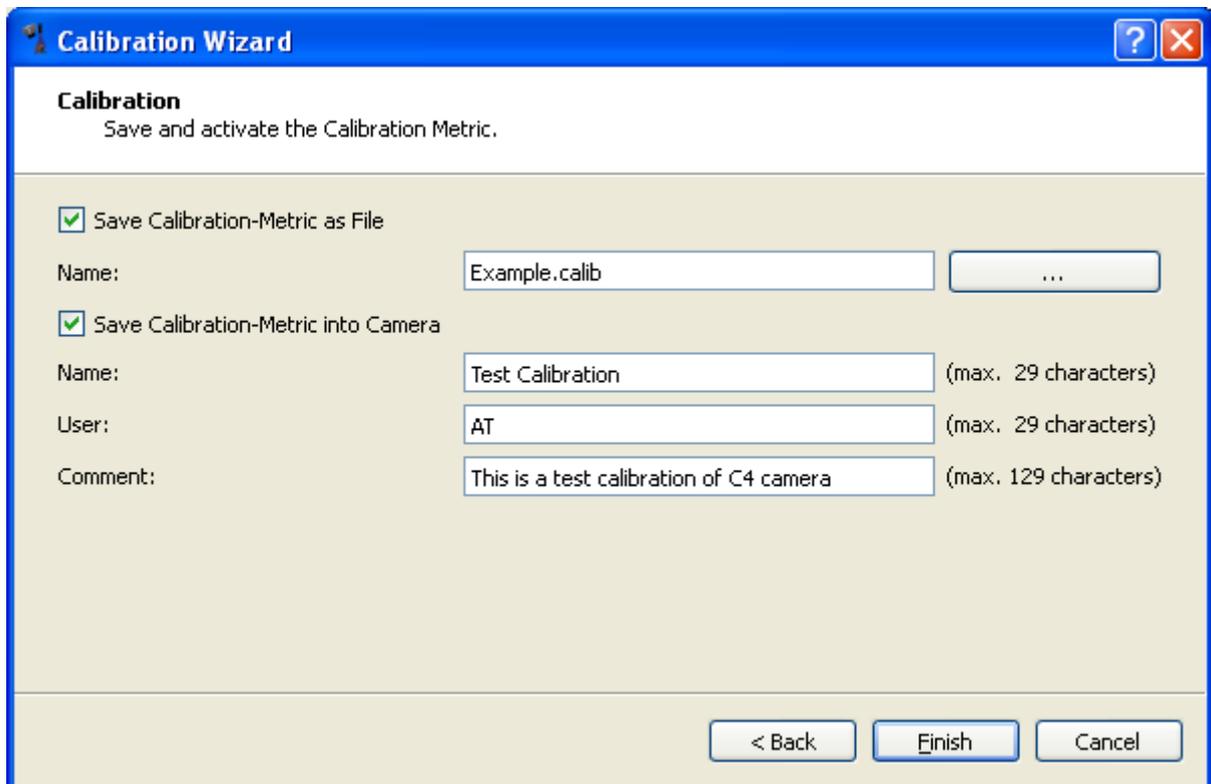
Press the “Calibrate” button to start the metric calibration procedure.

The calibration results are shown:



Click "Next" to proceed further.

Enter the filename to save the resulted metric calibration file. This file is required for scaling the 3D profile data in mm. Moreover, it is possible to store the calibration metric file permanently inside the camera.



Click "Finish" to save the calibration metric and close the wizard.

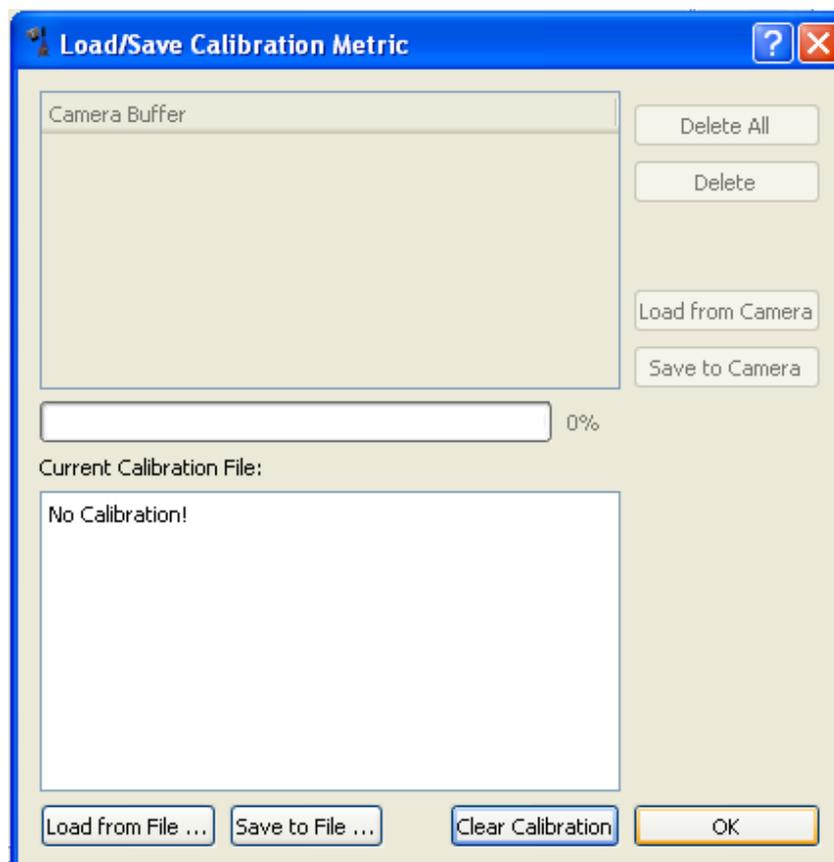
After finishing the calibration wizard, the system becomes ready to scale profile data in mm. The "ImageView" enables now the display of profile data in mm.

Furthermore, by clicking  the "LinePlot" shows the height profile in mm. Click  to plot the height profile by keeping the aspect ratio.

If required, the height image can be exported as a 3D point cloud file. Select menu "File" → "Export Image..." and set file type to "XYZ".

### Useful Information

- the calibration results are depending on the AOI settings ("AoiOffsetY"). In order to avoid this dependency, it is recommended before performing calibration to configure the camera to output the height position data using absolute coordinates. Set register "CameraControls" → "ModeAndAlgorithmsControl" → "Use absolute position" to true
- the path and filename of geometry file can be stored permanently. From menu "File" → "Preferences" → "Calibration"
- the scaling of profile data in mm requires the calibration metric contained in a file with the extension ".calib", which can be loaded at any time by selecting menu "Device" → "Load/Save Calibration Metric".



Click  to load the calibration metric from a file.

Click  to load the calibration metric from the camera.

Once the calibration metric is loaded, it can be saved either to a file or to the camera.

Click  to save the calibration metric to a file.

Click  to save the calibration metric in the camera

In this way, it is possible to transfer previously saved calibration data into the camera.

# Service Information

---

## Document Revision

Rev. Nr.	Date	Modification
1.0	04.08.2010	First version
1.1	08.09.2011	Added lens calibration
1.2	06.06.2012	Added lens calibration patterns, load/save calibration metric
1.3	07.06.2012	Added screenshot of Finish Calibration Wizard dialogue and drawing of static calibration pattern
1.4	15.07.2014	Update design of static calibration pattern

---

## Product Information and Updates

Updates

[www.AutomationTechnology.de](http://www.AutomationTechnology.de)

Service and Support

[service@AutomationTechnology.de](mailto:service@AutomationTechnology.de)

Product Inquiries and Price Quotations

[info@AutomationTechnology.de](mailto:info@AutomationTechnology.de)