chromasens
Imaging for Professionals

3DPIXA | Getting Started

CD40135 R03

Table of Contents

1 About Chromasens

The name of our company, Chromasens, is a combination of 'Chroma' which means color, and 'Sens' which stands for sensor technology.

Chromasens designs, develops and produces high-quality and user-friendly products:

- Color line scan cameras
- 3D stereo line scan cameras
- Multi-spectral line scan cameras
- Camera systems
- Camera illumination systems
- Image acquisition systems
- Image processing solutions

Today, Chromasens GmbH is experiencing steady growth and is continually penetrating new sales markets around the globe. The company's technologies are used, for example, in products and for applications such as book and document scanners, sorting systems and inspection systems for quality assurance monitoring.

Customers from all over the world of a wide range of industrial sectors have placed their trust in the experience of Chromasens in the field of industrial image processing.

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Visit our website at http://www.chromasens.de for detailed information on our company and products.

2 Components needed

2.1 Hardware

✔ 3DPIXA camera (shipped)

3DPIXA Compact	3DPIXA Dual
	
One line scan sensor with two Lenses in front	Two Line scan sensors with one lens in front of each sensor for Master and Slave Camera

Product Name	CP Number	built-in camera type
3DPIXA wave	CP000600-…	allPIXA wave
3DPIXA pro	CP000520-…	allPIXA pro
3DPIXA	CP000470-…	allPIXA

Link homepage https://chromasens.de/en/produkte/zeilenkameras-fuer-die-3d-inspektion

☐ Moving stage/Conveyer:

- The moving stage should be of high quality in order to achieve high accurate 3D-measurement results. The moving stage should have a stable and non-vibrating movement. Note that vibrating moving stages influence the measurement results.

☐ Optional: Lifting Table

- Fine scale lifting table might be needed if objects with different heights are measured. Your object can be placed at the best focus plane of the camera with the help of the lifting table. A lifting table is especially recommended, e.g. for a 3D-demonstration scanner system and if it is difficult to lift up and down your 3DPIXA camera.

☐ CameraLink Framegrabber(s)

Supported CameraLink Modes for 3DPIXA

Product Name	CP Number	CameraLink Mode
3DPIXA wave	CP000600-…	Base / Medium / Full
3DPIXA pro	CP000520-…	Base / Medium / Full
3DPIXA	CP000470-…	Base / Medium

- 3DPIXA compact: 1 x Full / Medium / Base Framegrabber
- 3DPIXA dual: 2 x Full / Medium Framegrabber or 1 Dual Base Framegrabber

Dependent on required scanning speed, 3DPIXA can be operated in Base or Medium of Full mode. For more information about compatible Framegrabber, refer to chapter 6.6 in the appendix.

☐ Line Scan Illumination (Can be ordered on request)

- Chromasens manufactures its own high quality line scan illumination “Corona II” Please contact us for further information about our line scan illumination varieties.

☐ CameraLink Cables:

- 3DPIXA compact: 2x CL-cables for Full/Medium mode, 1x in base mode
- 3DPIXA dual: 4xCL-cables for Full/Medium mode, 2x in base mode

The 3DPIXA provides **MDR connectors**. Check the connectors of your Framegrabber to choose MDR-MDR or MDR-SDR CameraLink cables.

- Power-Cable(s): Hirose 6-pin plug “female” (HR10A-7P-6S) (Can be ordered on request)
  - 3DPIXA compact camera: 1 x Power Cable
  - 3DPIXA dual camera: CP000600-… and CP000520-… 1 x Power Cable
  - 3DPIXA dual camera: CP000470-… 2 x Power Cable
- Optional: Encoder/Light barrier If using 3DPIXA dual camera, a frame start signal must be connected to the Master camera to ensure the acquisition of two images simultaneously
  - Encoder - Line trigger
  - Light barrier - Frame trigger

  Please note: The allPIXA wave camera is able to emulate a frame scan camera. Output data are in real frames, and the VSync signal (or FVAL = frame valid signal) is generated.
- PC with correct configuration setting
  - System: Windows 7, 8.1, 10 x 64
  - Quad Core i7 > 2,4 GHz
  - >16GB RAM, 32GB recommended
  - Enough PCIe slots for GPU and Framegrabbers - The installed GPU might occupy lot of space inside the PC and hinder the access to other PCIe slots
  - CUDA 3.0 capable GPU hardware with at least 3 GB RAM (see in the appendix chapter 6.8 for tested GPU’s)
  - Enough power supply for the GPU
  - NVidia Driver Version 441.87 or newer
- Software-Protection dongle (silver USB-stick) (included)
  - Required for 3D calculation with the 3D-Software
- Chromasens 3D-Software USB-Stick (orange USB-stick) (included)
  - Includes software, drivers, calibration files, technical drawings, etc.

    See also Homepage -> https://www.chromasens.de/en/3DPIXA-downloads
- Power supply for
  - 3DPIXA compact -> 24 VDC +/- 10 %; 1A; typical 16 W
  - 3DPIXA dual -> 24 VDC +/- 10 %; 2A; typical 40 W
  - XLC4 for Chromasens Corona II illumination -> 24 VDC and up to 20 A

    Please note: The XLC4 requires up to **20 A** of current to operate the LED at maximum brightness. Please choose a suitable power supply.
  - Moving stage, trigger devices etc.
- Software

  Can be found in the Chromasens 3D-Software USB-stick (orange USB-stick)
  - 3D-Viewer and 3D-API (included)
  - CST (included)
  - XLC4-Commander for Corona II illumination (included)
  - 3DPIXA Configuration and Calibration File (included)
  - Framegrabber software for image acquisition (should be included by the Framegrabber manufacturer)

3 Setup your 3DPIXA system

In the appendix chapter 6.1, you may see an example of a 3DPIXA demonstration setup. Follow the steps below to build up your own 3DPIXA Setup.

1 Prepare your moving stage/conveyor (e.g. conveyer/linear table)

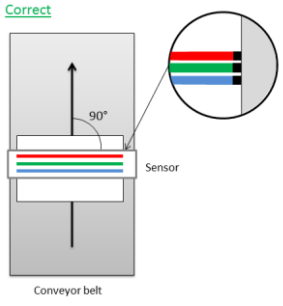
- Check for stable consistent movement of your moving stage/conveyor.

2 Optionally: Prepare your lifting table

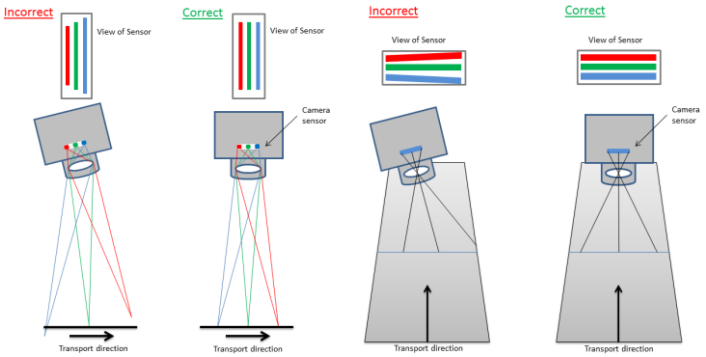
- Make sure, it is possible to do fine adjustments with your lifting table in order to place your object in the best focus plane of the 3DPIXA camera. Take into account, height of object.

3 (See chapter 6.2): Mount your 3DPIXA at the correct working distance

- The sensor line should be adjusted perpendicular (90°) to the transport direction and the camera's longitudinal and transverse axis should be perpendicular (90°) to the inspection area. Make sure the camera is not tilted.
-



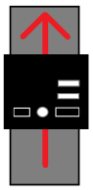
Sensor line



Perpendicularity of the camera to the inspection area

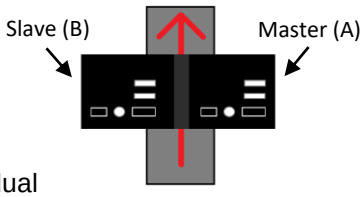
- Mount your 3DPIXA at the correct working distance . The working distances are described in chapter 6.2. Note!! Take account of object height. At the end, it is the object which has to be in the correct working distance.
- The forward scan direction is as illustrated below. With modifications, it is possible to scan in both directions.

Top View:



3DPIXA compact

Top view:



3DPIXA dual

- **3DPIXA dual camera: (See chapter 6.2.2 for detailed description of 3DPIXA dual camera installation)**

4	**Setup your line scan illumination at the correct focusing point** • Mount your illumination at the correct working distance / adjust the focusing point of your illumination. • Your 3DPIXA camera should be looking at the brightest illuminated area of your illumination. • **Chromasens Corona II Illumination:** If using Corona II Illumination, see chapter 6.3 to setup your line scan illumination.

5	**Prepare your PC**
	
	• Install the required cards:
	  • Install your GPU
	  • Install your Framegrabber
	  • Optionally: Install your RS232 port (Corona II Illumination (Chapter 6.3))
	• Turn on your PC
	• Install the NVidia Driver - The driver can be downloaded from the website http://www.nvidia.de/download/index.aspx

6	**Optionally: Encoder (Line trigger) and light barrier (Frame trigger)**

- Install encoder and light barrier based on your respective application
  - If your encoder and light barrier signal are connected via the Framegrabber to the camera, please connect the signals as follows:
    - Encoder signal should be connected to CCbit1
    - Light barrier signal should be connected to CCbit3
  - You may connect your encoder directly to the camera. Various options - including LVTTL max. 3.6V and RS422 standards - are possible to connect your encoder and light barrier to the camera and are described in the allPIXA manual – Digital I/O-Port (Chapter 6.4).
- **Only with 3DPIXA dual cameras:**
  - A frame start signal is required and necessary to ensure the acquisition of two images simultaneously. This can be fulfilled by e.g. a light barrier
  - The trigger signals should be transmitted to the Master Camera. The Master camera automatically transfers the trigger signal to the Slave camera with the initial setting of the camera, if a Master/Slave cable is connected between the two cameras

Please refer to the allPIXA manual for installing an encoder/line trigger to your setup.

CP000470 -> allPIXA
CP000520 -> allPIXA pro
CP000600 -> allPIXA wave

7	**Connect the cables**

- Connect the 3DPIXA camera to the Framegrabber via CameraLink Cables.
- Connect the 3DPIXA camera to a suitable power supply
  (24 VDC +/- 10 %; compact 1A; typical 16 W and dual 2A typical 40 W)
- **Only with 3DPIXA dual cameras with CP000470**
  Connect a master/slave cable to the camera
  - You may find an instruction to do a Master/Slave cable in chapter 6.2.3

4 Commissioning of 3DPIXA

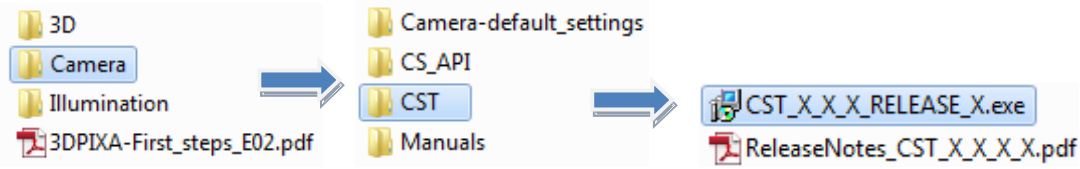
- Make sure, the CameraLink Cables are connected to the correct ports of the camera and the correct ports of the Framegrabber
- Make sure, the Power cables are connected to a suitable power supply - Instable or wrong power supply may cause camera damage.
- Turn on the Power supply
- Turn on the Illumination (If using Chromasens Corona II, see chapter 6.3 to turn on your illumination)
- Open your image acquisition software and check the Framegrabber settings (Framegrabber settings should be as stated as below):
    - base mode: The tap configuration is 1 tap with 24 bits (1X)
        - 3x8 bit = 24 bit/pixel; 1 Pixel per Cycle; RGB; Image size/width: 7296, Line scan mode
    - medium mode: The tap configuration is 2 taps with 24 bits (2XE)
        - 3x8 bit = 24 bit/pixel; 2 Pixels per Cycle; RGB; Image size/width: 7296, Line scan mode
    - full mode: For CP000520.. and CP000600… also Full mode is available
        - Full64 mode / Full80_ 8Tap_10Bit / Full80_ 10Tap_8Bit

Note Area Applet for FVAL is recommended

- Place a white reference paper in the FOV(field of view) and of the 3DPIXA
- Adjust focus so that your white reference paper is in focus of the 3DPIXA
- You should be able to grab an image in medium mode by now. If you are using the 3DPIXA in base mode, refer to chapter 6.4 to set your camera to base mode.
    - Note that the line frequency will be limited if using the 3DPIXA in base mode. Full performance of the 3DPIXA can be reached by using the 3DPIXA in medium mode.
- Observe a live image. Setup and adjust your illumination so, that the 3DPIXA is looking at the brightest illuminated area of your illumination. You may move your illumination unit forward and backward or change the angle of your illumination and observe the live image grabbed by the 3DPIXA. You should adjust your illumination at that point, where the image is at its brightest.

Now, your 3DPIXA setup should be correct. By now, your 3DPIXA camera should have been installed at the correct position (90° perpendicular to inspection area, the camera is not tilted) and should look at the brightest illuminated area of your illumination.

- Make sure, your moving stage has a stable movement.
- Plug the orange USB-stick into your PC. The orange USB-stick contains the main important software for your 3DPIXA application.
- Install CST- CST is used to setup the camera parameters



Follow the instructions of the CST installation setup.

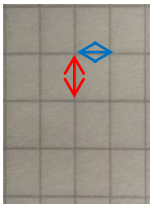
- Adjust your illumination and the integration time so, that your white reference has a video value of about 220. Refer to chapter 6.5 for adjusting integration time. You may want to do white balancing at this point. (chapter 6.6).

- Place a scaled paper in focus of your 3DPIXA. The scaled paper may look like shown below.

 (Scaled paper)

- Grab an image with your Framegrabber software of your scaled paper with moving linear stage.
- You may want to have a correct image dimension so that there is no distortion of the image. You may use an encoder/line trigger to ensure a correct image without distortion. Please refer to the allPIXA manual for installing an encoder/line trigger to your setup for correct image dimension. If you do not use an encoder, the following instruction should help you to have a correct image dimension.
    - Possible occurring distortions:
        -  Image 1: Your image looks compressed- Your moving stage is likely running to fast or your integration time is too high.

          Decrease your transport speed or set a smaller integration time (chapter 6.5)

        -  Image 2: Your image looks stretched- Your moving stage is likely running to slow or your integration time is too small.

          Increase your transport speed or set a higher line period (chapter 6.5)
    - Calculation of how the line period or moving stage should be adjusted
        - The blue stays stable no matter of the transport speed.
        - The red array differs dependent on transport speed, if no encoder/line trigger is used.
        - Have the scaled paper in focus of the 3DPIXA before the next step

      Count the amount of the pixels of the blue and the red array.

      In the example above:

      Image 1: 17 pixels; 10 pixels

      10/17 = 0.588 * current transport speed = New resulting transport speed or

      10/17 = 0.588 * current integation time = New integration time to be set

      Image 2: 17 pixels; 24 pixels

      24/17 = 2 * current transport speed = New resulting transport speed or

      24/17 = 2 * current Line Period = New line period time to be set
    - Refer to chapter 6.5 for adjusting the integration and the line period time.
- Do White balancing:

  You may want to do White balancing of your 3DPIXA to get best results of your 3DPIXA. The steps for white balancing are described in chapter 6.6
- Now, your 3DPIXA camera should be ready for image acquisition. A sharp and good illuminated image should be acquired with your 3DPIXA. This image can then be used to calculate 3D data.

5 Using the 3D-Viewer

- Plug the software protection dongle (silver USB-stick) into a USB-slot of your PC
- Before using the 3D-Viewer, **a sharp, well illuminated image with texture** has to be acquired. Do not start doing 3D calculations before you have acquired a good image.
    - Your image should have
        - 8, 24, or 32 bit – png, bmp or gif format
        - image width: depends on the calibration and configuration
    - You will need
        - With 3DPIXA compact:1 raw image to calculate the 3D data with the 3D-Viewer
        - With 3DPIXA dual: 2 raw images from the two cameras to calculate the 3D data with the 3D-Viewer
- Make sure, your object is in the best focus plane of the 3DPIXA. You may need to zoom in to evaluate the sharpness of your image. Adjust height of lifting table accordingly.

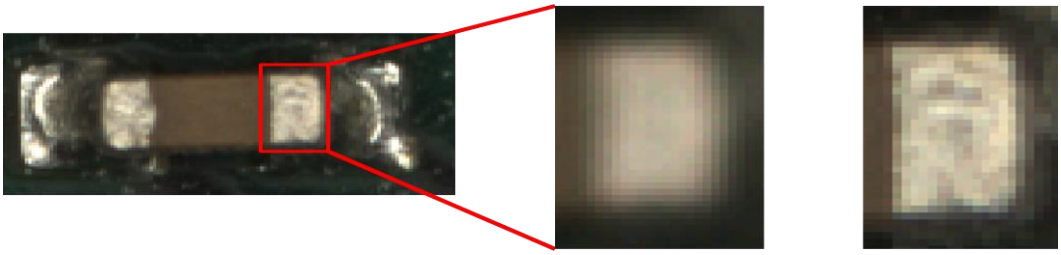
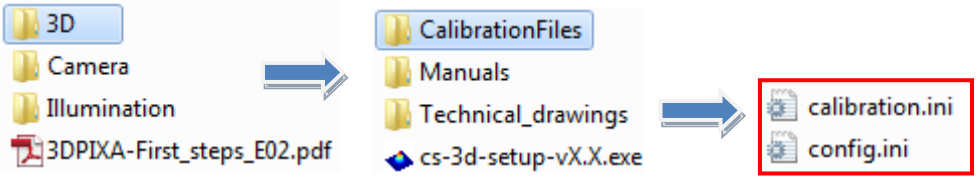


Fig. 1: Zoom in to evaluate sharpness of your acquired image.

- If you have acquired a satisfying image, install 3D-Viewer. The 3D-Viewer is contained in the orange USB-stick in the following directory. Follow the instructions of the Setup.

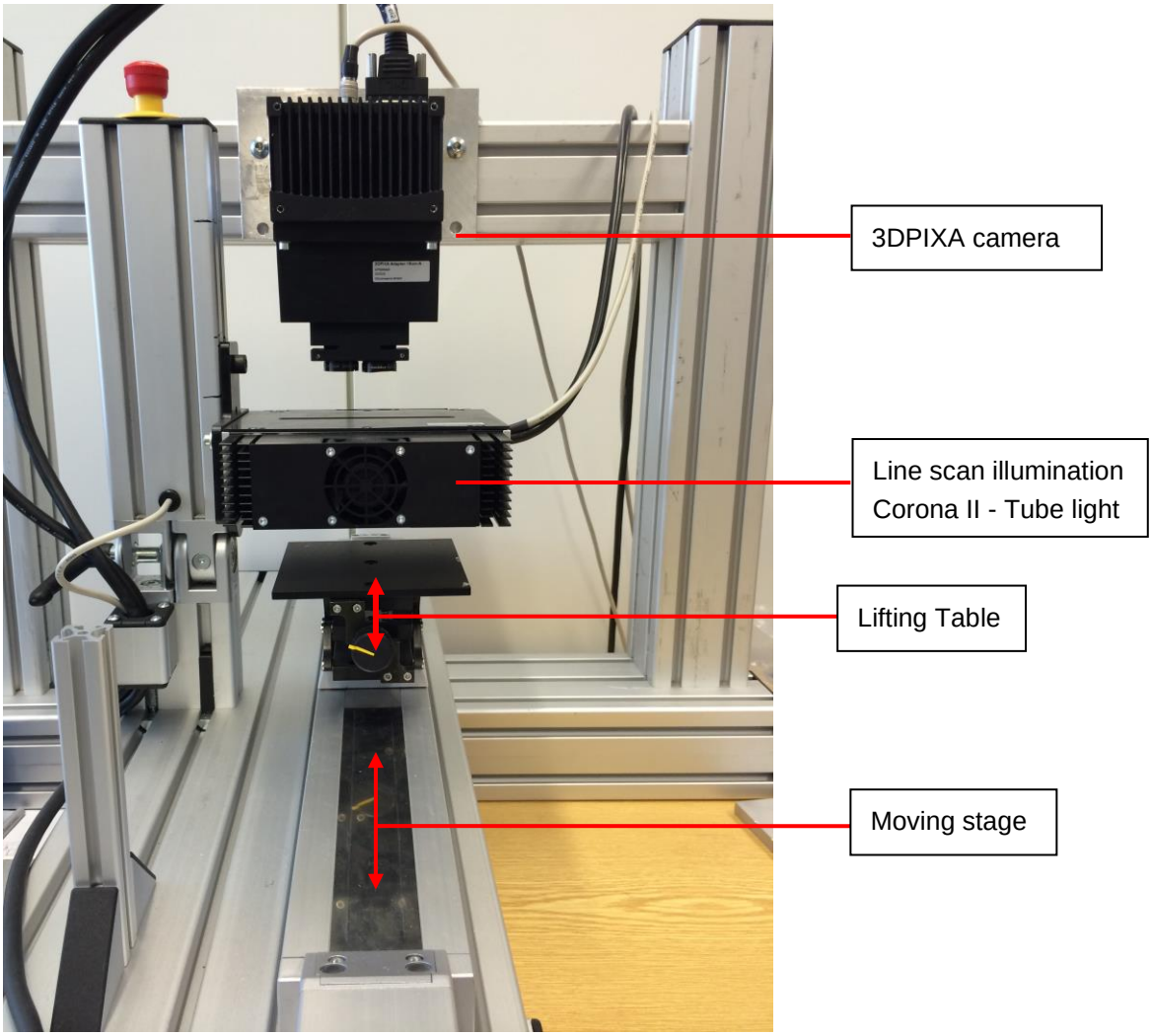
- After installation of the 3D-Viewer, save the Calibration Files "config.ini" and "calibration.ini" locally on your computer to your preferred directory, preferably, where your acquired raw images shall be saved. You find them in the directory shown below.



- Open the 3D-Viewer
- You may start doing your first 3D calculations with the 3D-Viewer by now. Start with the 3D-Viewer manual to do your first 3D calculations. In the 3D-Viewer manual, there is a "Getting started" chapter (chapter 3). Follow the instructions in that chapter and you will obtain your first 3D calculation results.

6 Appendix

6.1 Example of a 3D demonstration scanner setup



6.2 Mechanical installation

Mount your 3DPIXA at the correct working distance.

The distance between camera front-plate and the object-plane (free working distance):

- 3DPIXA compact 15 µm: 99.6 ±0.1 mm
- 3DPIXA compact 30 µm: 173.6 ±0.1 mm
- 3DPIXA dual 5 µm: 71.9 ±0.1 mm
- 3DPIXA dual 15 µm: 229 ±0.5 mm
- 3DPIXA dual 30 µm: 413.3 ±0.1 mm
- 3DPIXA dual 70 µm: 796.9 ±0.1 mm

Make sure your camera is positioned correctly.

The sensor line should be adjusted horizontally to the transport direction and the camera should look perpendicular to the inspection area.

Check Homepage for technical drawing: https://chromasens.de/de/3dpixa-downloads

6.2.1 Technical drawings

The detailed technical drawings can be found in the directory: [orange USB-Stick]/3D/Technical Drawings

6.2.2 3DPIXA dual camera installation

The 3DPIXA dual camera offers precise 3D calculations with the condition that it has been mechanically installed very precisely. Tilting of the camera leads to wrong calculation results.

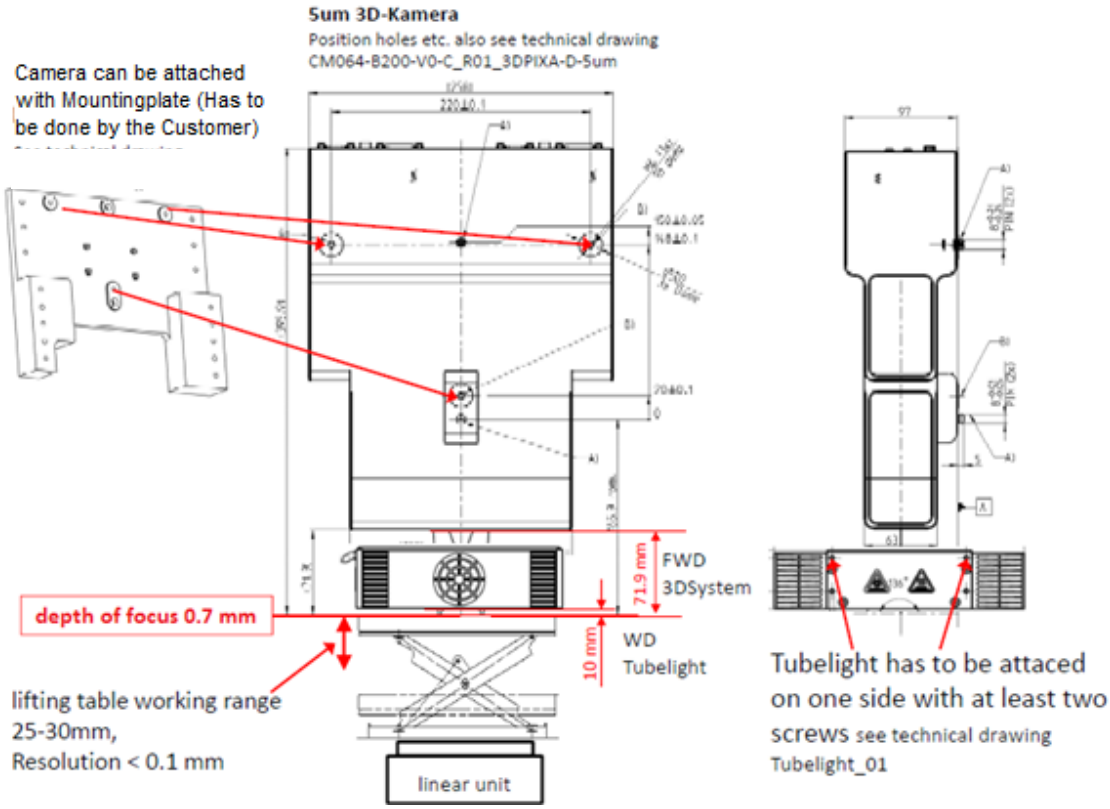
The sensor line should be adjusted horizontally to the transport direction and the camera should look perpendicular (90°) to the inspection area like mentioned in the Setup (Chapter 2, Step 3) before . Make sure the camera is perpendicular to the inspection area.

On the 3D dual cameras, 2 pins are attached on the camera housing These can be used to fix the 3DPIXA precisely. (Please refer to the technical drawings for the location of the 2 pins - chapter 6.2.1).

3DPIXA 5 µm dual: Please note: The 3DPIXA 5 µm dual camera offers highly precise 3D calculations. The system setup has to be installed very properly to ensure good reliable results.

If it is not possible to adjust the camera position with the 2 pins at the rear of the camera, please see the example approach of fixing the 3DPIXA camera below:

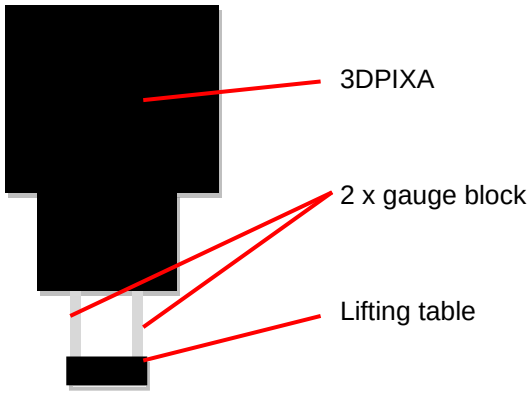
Example approach for setting up a 3DPIXA demonstration scanner based on the 5 µm 3DPIXA model:



- You may want to work with gauge blocks while installing the 3DPIXA in order to avoid transversal tilting of the camera.
- Your lifting table shall be in an upper position, so that you may lower the lifting table in order to place your object in best focus when your object is on the lifting table.
- Mount your 3DPIXA to a mountingplate (Has to be done by the Customer)
- E.g Put your gauge blocks on both sides of the lifting table (See figure below).
- Place the front plate of your 3DPIXA on the gauge block.

  Beware!: Do not scratch the glass plate of your 3DPIXA!

  Take note of the load-bearing capacity of your lifting table. Do not overweight your lifting table.



- Fix your 3DPIXA camera with the 3DPIXA camera plate on a stable scaffold.
- Lower your lifting table and remove the gauge block.
- Check again, if the sensor line of the 3DPIXA is straight horizontally to the transport direction and the camera's longitudinal and transverse axis are perpendicular (90°) to the inspection area.

6.2.3 Master/Slave Cable (Only for 3DPIXA dual with CP000470..)

You will need 2 x 15-pin D-Sub connector (male) to make a Master/Slave cable for your 3DPIXA dual camera. If you wish to connect your encoder/light barrier directly to the Master camera, please refer to the allPIXA manual.

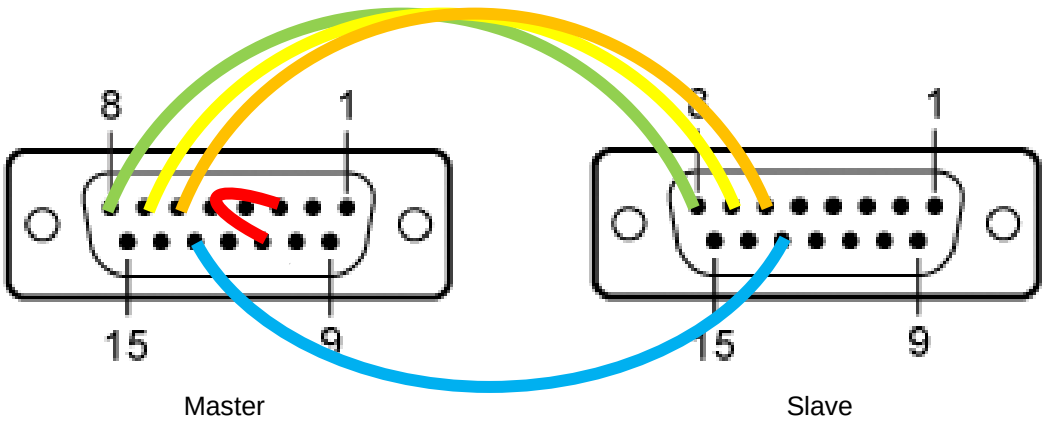
The following table shows, how the wires shall be connected to the D Sub 15 connectors. An example is shown below.

NOTE!: Take note of correct PIN-Number. Wrong connections may lead to damage of the camera

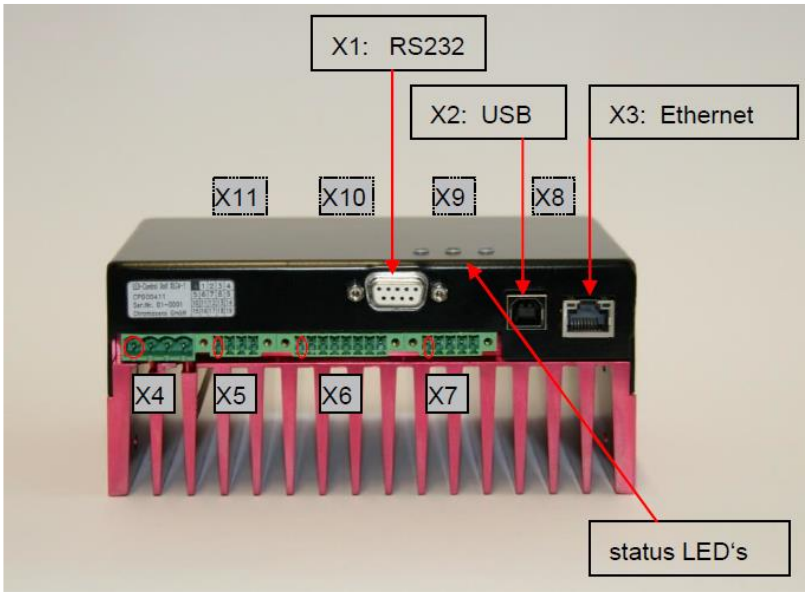
Pin	Master	Pin	Slave
1	Incremental encoder (high, Optional)	1	Open
2	Light barrier (high, Optional)	2	open
3	**nSelMaster (Bridge to 0 V)**	3	**Open, internal PullUp**
4	-	4	-
5	open	5	open
6	**Master/Slave-interface**	6	**Master/Slave-interface**
7	**0 V**	7	**0 V**
8	**Master/Slave-interface**	8	**Master/Slave-interface**
9	Incremental encoder (low, Optional)	9	Open
10	Light barrier (low, Optional)	10	open
11	**0 V(Bridge to nSelMaster)**	11	-
12	-	12	-
13	**0 V**	13	**-0 V**
14	-	14	-
15	open	15	open

1:1 connections

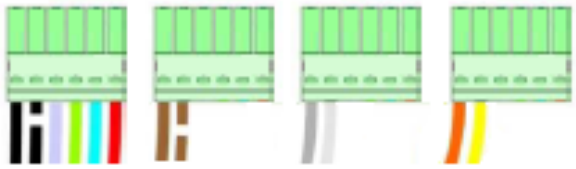
Example of a Master/Slave Cable:



6.3 Setting up Corona II with XLC4



- **Step 1:** Connect your Corona II illumination to **X8-X11** of the XLC4-LED controller as shown below



X8 **X9** **X10** **X11**

- **Optional:** With fan cooled Corona II: Connect the fan-plug (with white and brown cable) to **X5**
- **Step 2:** Connect your XLC4 to a suitable power supply at **X4** (24V)

1	V_IN	Supply Voltage
2	V_IN	Supply Voltage
3	GND_IN	0V (signal ground)
4	GND_IN	0V (signal ground)

Pin X4: From left to the right: pin 1,2,3, and pin 4

- **Step 3:** Turn on the power supply

  Wait until the red LED burned for about 4 sec, and then the green LED blinking every 4 sec. Now, your XLC4 is ready in operation.

- **Step 4:** Connect your XLC4 with the computer.

  We suggest using **RS232-serial interface (X1)** to connect the XLC4-LED controller to the computer. Proceed to step 5, when the XLC4 is connected to the computer via RS232.

  - If no RS232-serial port on the computer is available, use RS232-USB converter with FTDI chipset to connect the XLC4 with the computer via **X1**.
  - Alternatively, it is possible to connect the XLC4 with Ethernet **(X3)** or USB **(X2)** to the computer.
    - If using Ethernet, you have two possibilities to connect the computer with the XLC4
      - Connect your computer with the XLC4 via a switch:

Plug in an Ethernet cable from the computer to the switch

Plug in an Ethernet cable from the XLC4 to the switch

Check that the LEDs at the Ethernet port are illuminating

Please continue with Step 5.

- Connect your computer with the XLC4 directly:

  Plug in an Ethernet cable from the computer to the XLC4

  Set a static IP address to the computer (TCP/IPv4), which has the first 3 numbers same as the numbers of the XLC4-IP address which is per default 192.168.87.234 (e.g., you may give your computer the IP address 192.168.87.1). Please continue with Step 5.

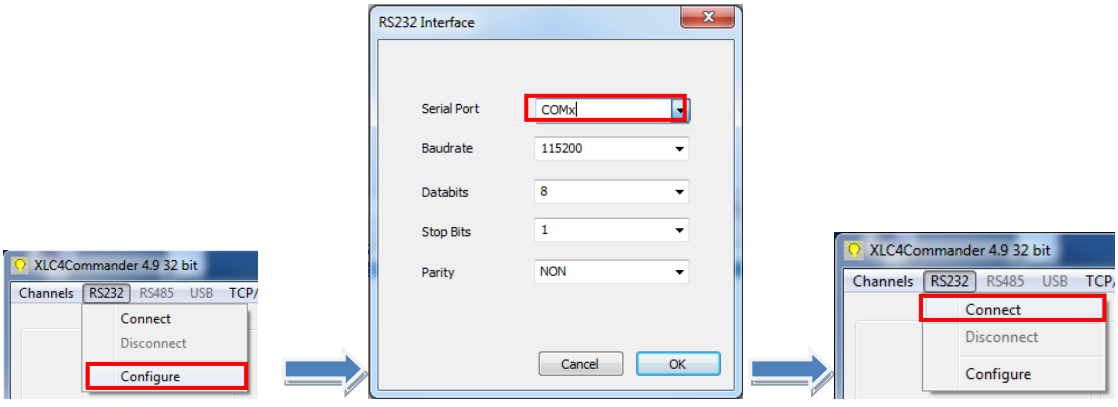
- If using USB, a virtual COM-port has to be generated and the computer will communicate with the XLC4 via the COM-port.
  - Plug in the USB cable into the XLC4 and on the other end into the computer
  - Windows 7 64 bit: Install “pic32mx_usb_v1.04”. This program can be found in the following directory: [USB-Stick]\Illumination\Drivers\USB-Driver . Per default, the drivers will be installed in “C:\pic32_solutions”. If the installation was not successful, you may install the driver for “CDC RS-232 Emulation Demo” manually from this folder “C:\pic32_solutions”, as it contains the driver for emulating the virtual COM-port. Please continue with Step 5.

    Windows XP & Windows 7 32 bit: Copy mchpcdc.inf and mchpcdc.cat to a destination folder on your PC. This program can be found in the following directory: [USB-Stick]\Illumination\Drivers\USB-Driver. Install the driver of the hardware “CDC RS-232 Emulation Demo” manually. The driver can be found in the folder you’ve put mchpcdc.inf and mchpcdc.cat in. If the installation was successful, a virtual COM-port should have been generated. Please continue with Step 5.

- **Step 5:** Establish connection with the XLC4 / Turn on the illumination
  - Copy XLC4Commander_Vx_x.exe locally on your computer. XLC4Commander can be found at [USB-stick(orange)]/Illumination
  - To start the program, double click on the program

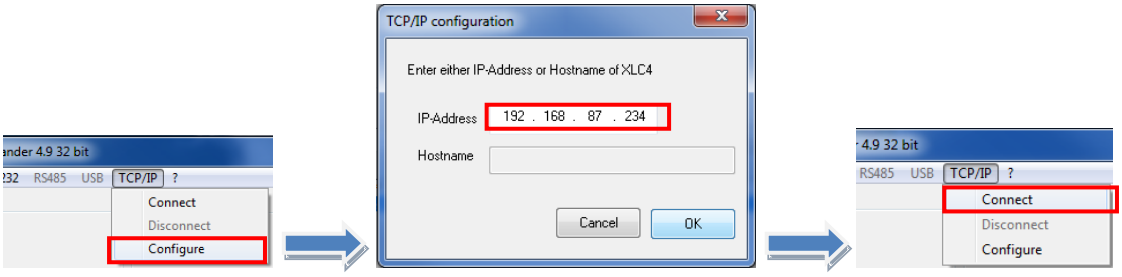
Connection via RS232 and USB:

Find out and select the correct COM-port, then connect to the XLC4-controller. The COM-ports available can be found in the “Device Manager”

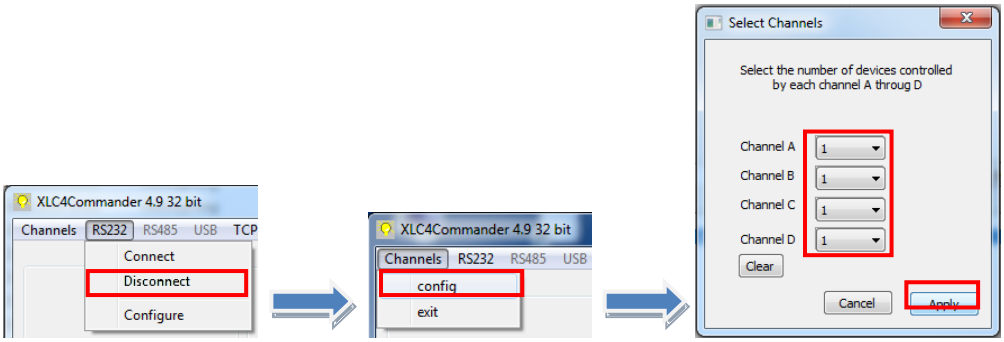


Connection via Ethernet:

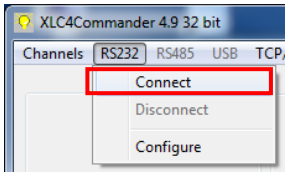
Type in the correct IP address and connect to the XLC4-controller. The IP-adress is per default 192.168.87.234. If it is not possible to connect to the XLC4-controller, you may use RS232 interface and connect to the XLC4 first to find out the IP address of the XLC4.



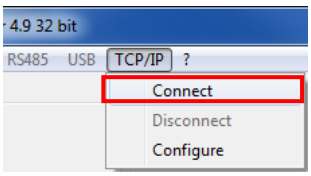
- If not all channels can be turned on/connected,
  - Disconnect
  - Configure the channels manually like shown below. All channels should have a value of 1.



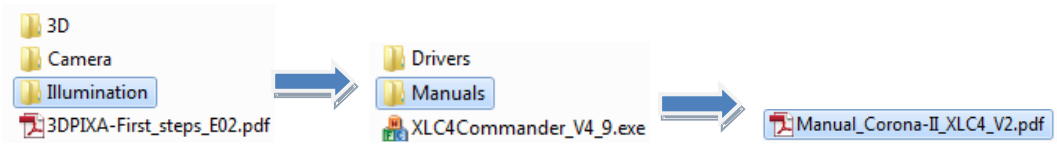
RS232/USB



Ethernet

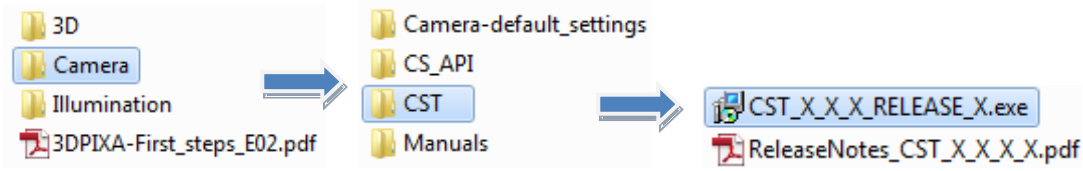


- **Important!:** To prevent overheating in fan cooled Corona II, type in at the “Enter XLC4-Command” line “FA 0x0008”, click the “Send”-Button, then type in “FC 55,55” and click the “Send”-Button. Now, your fan should turn on at the temperature 55°C
- **Note!:** To prevent electromagnetic interference, connect the shielding of the Corona II cable to ground.
- Refer to the Manual_Corona-II_XLC4_VX.pdf chapter 7.2.4 to turn on the illumination. It is located in the directory shown below.



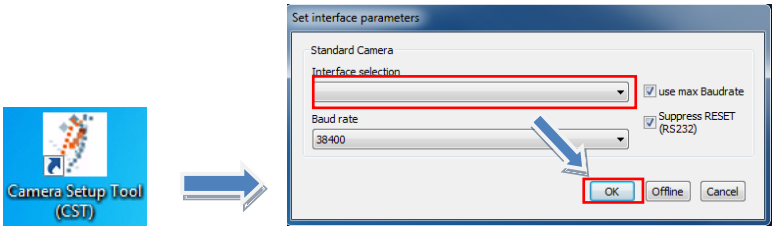
6.4 Setup CameraLink Base mode

To set up your camera to base mode, you will need to install CST - CST is used to setup the camera parameters. You will find CST in the orange USB-stick provided.

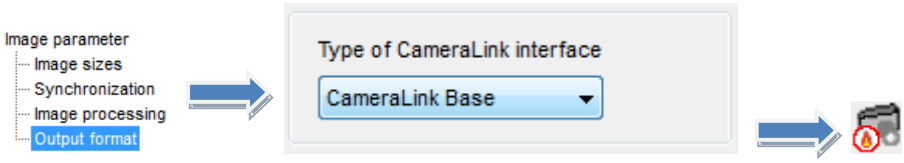


Follow the instructions of the setup and install CST.

Open CST. Choose the COM-port of which your camera is connected to. Usually your camera is connected via CameraLink to the Framegrabber. Choose the COM-port of your Framegrabber in this case.

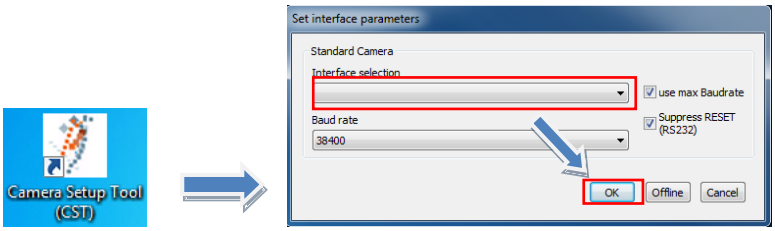


Select „Output format“ on the left, choose „CameraLink Base“ as desired output format and burn the setting into the camera

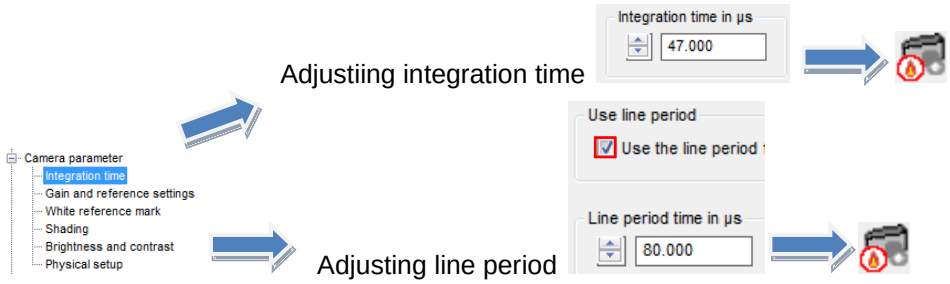


6.5 Adjust integration time and line periode

Open CST. Choose the COM-port of which your camera is connected to. Usually your camera is connected via CameraLink to the frame grabber. Choose the COM-port of your Framegrabber in this case.



- Integration time adjustment: Select „Integration time“ on the left, type in the desired integration time and burn the setting into the camera



- Line period time adjustment: Select „Integration time“ on the left, enable „Use the line period“, type in the desired „Line period time“ and burn the setting into the camera.

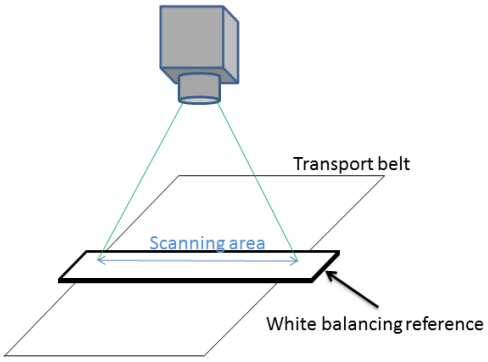
6.6 White balancing/ Set camera to operating condition

Follow the steps below to perform White balancing, blacklevel/offset- and shading correction with your 3DPIXA

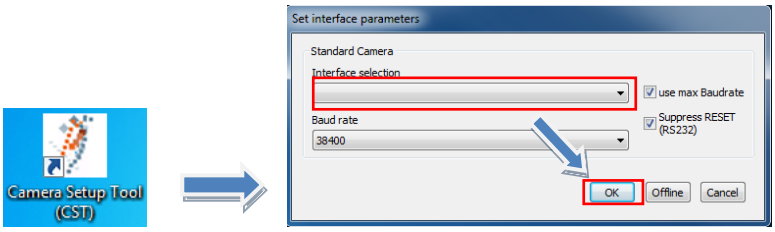
6.6.1 Pre-Setting

Make sure you have already setup your 3DPIXA correctly (Chapter 3) and have done the first steps of the 3DPIXA commissioning (Chapter 4).

- Turn on the camera and the illumination
    - Adjust your illumination brightness to your desired operating condition
- Make sure, your framegrabber has the correct setting
- Have your white reference in the FOV and the correct working distance of the camera
    - The white reference should be a non glossy material which has no texture or impurity, such as dust or scrathes, on its surface.



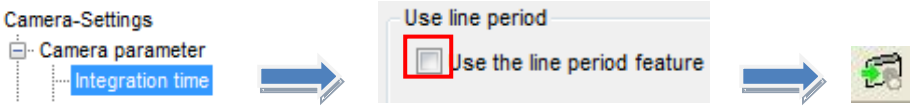
Open CST. Choose the COM-port of which your camera is connected to. Usually your camera is connected via CameraLink to the frame grabber. Choose the COM-port of your Framegrabber in this case.



Click the  -Button to get into the camera parameters setting. On the left side, you will have a list of camera parameters.

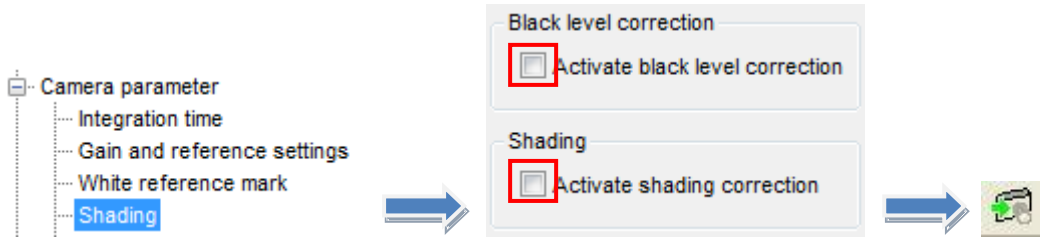
Make sure you have the following setting in your CST. If you have a 3DPIXA dual. Make sure, you have the following setting in both cameras.

Deactivate “Use the line period feature”

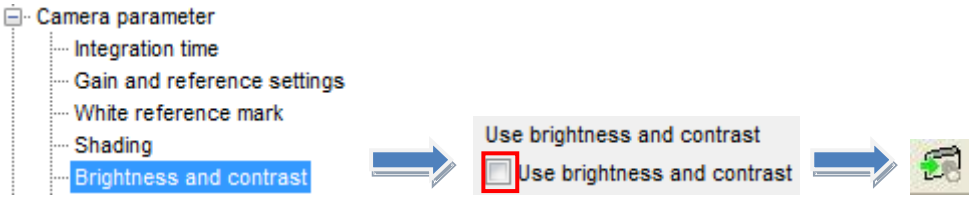


Note: 3DPIXA dual camera: Make sure both cameras have the same integration time.

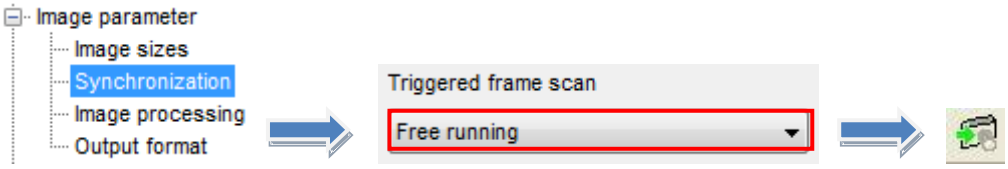
Deactivate Black level and Shading correction.



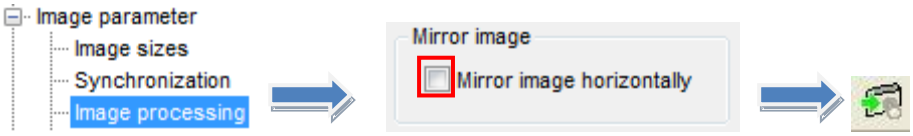
Deactivate Brightness and contrast



Set Synchronization to free running

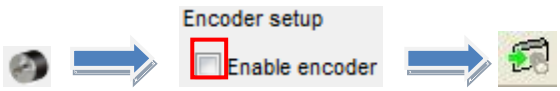


Disable Mirror image horizontally



Disable Encoder

Click the  - Button on the toolbar and disable the encoder

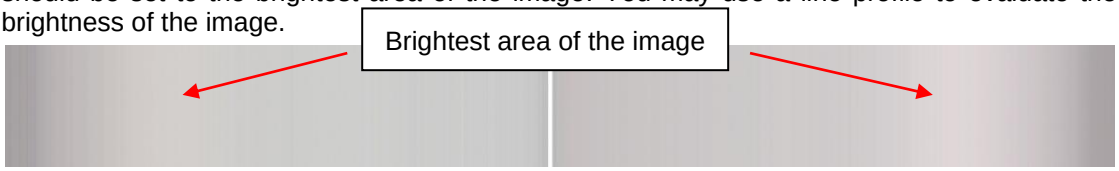


6.6.2 White balancing

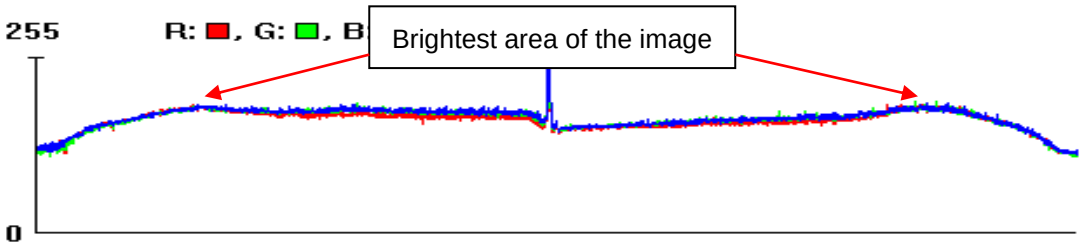
6.6.2.1 For 3DPIXA compact models

Step 1: Setup white reference mark position

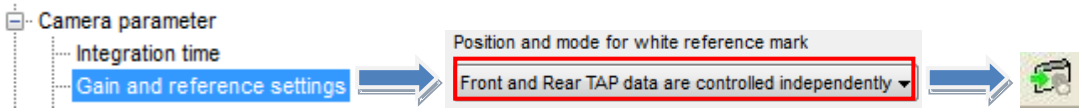
Observe a live image. A live image can be seen from your own application software or the software interface provided by the framegrabber manufacturer. The White reference mark should be set to the brightest area of the image. You may use a line profile to evaluate the brightness of the image.



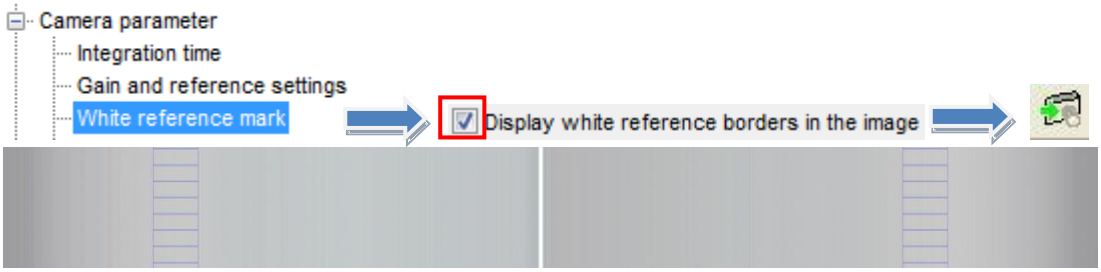
This is how your image could look like. It can be seen that the brightest area of the image are at the positions, where the arrows are.



Set tap control to „independently control“



Activate “Display white reference borders in the image”



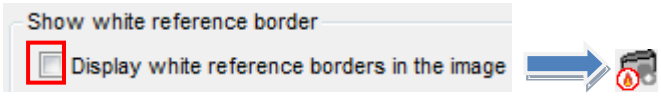
You should see the white reference mark at the brightest area of the image. If not, adjust position of the white reference mark accordingly by following the steps below.

You should see a value in the following box, e.g. 1000

Type in a smaller value than the actual value into the red box and transfer setting into the camera  to make the reference mark move leftward in the left image and rightward in the right image(see illustrations below). The mark should be at the brightest area of the image.

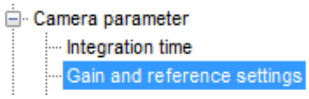
Type in a bigger value than the actual value into the red box and transfer setting into the camera  to make the reference mark move rightward in the left image and leftward in the right image(see illustrations below). The mark should be at the brightest area of the image.

If the reference mark is at the brightest region of the image, disable “Display white reference borders in the image” and burn setting to camera  .



Step 2: Adjust the camera gain values

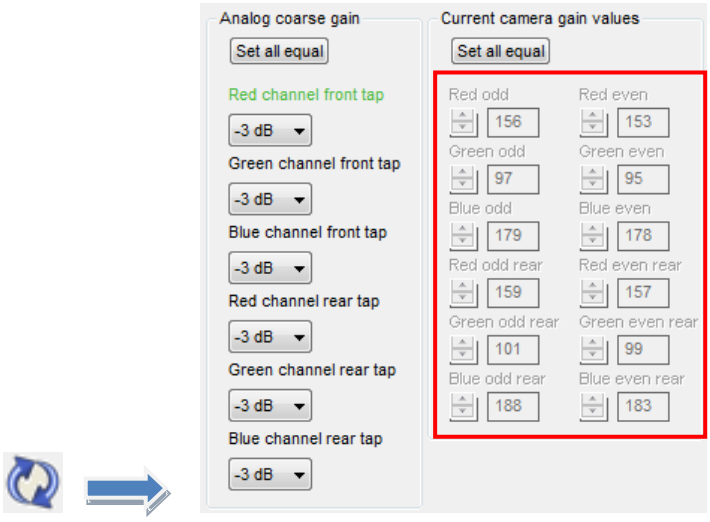
Adjust the gaining (amplification) values to achieve best image quality:
Get back to the „Gain and reference settings“



Enable „Continuous white control“

The signal amplification comprises of the two amplification levels: „Analog coarse gain“* and „Current camera gain values“.

The „Current camera gain values“ are recommended to be in the range of 80 – 200 (red box)
Click the  -Button and check the “Current camera gain values”.



1: If the current camera gain values are in the range of 80 – 200, you may proceed to step 3.

2: If the current camera gain values are higher than 200

→light up your illumination or

→increase integration time or

→increase analog coarse gain**

Then, click and . Check the “Current camera gain values” again.

3: If the current camera gain values are lower than 80

→decrease analog coarse gain** or

→decrease integration time or

→lower the intensity of your illumination

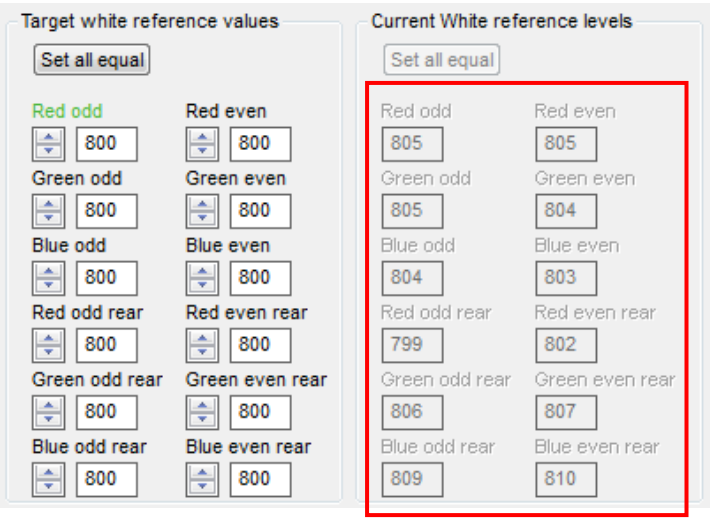
Then, click and . Check the “Current camera gain values” again.

**Analog coarse gain:

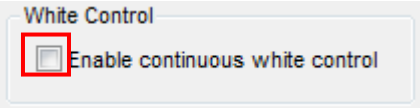
- pre-amplification factor: 1dB corresponds to 27.85 steps in “Current camera gain values”
- You can increase “Analog coarse gain” for all channels by changing the topmost value, clicking the “Set all equal”-Button then the -Button

Step 3: Save settings permanently

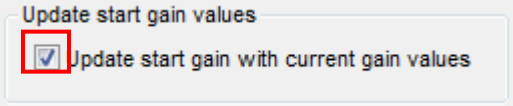
Check the “Current white reference levels”. They should be in the range of 780 – 820 (red box)



Disable “Continuous white control”



Directly update start gain
Values with current gain values



Now the “Start gain values” should be the same as the “Current camera gain values”. The camera will start up with the “Start gain values” once the setting has been burned permanently into the camera by pressing the -Button

Your 3DPIXA is white balanced. Due to lens vignetting (shading), the image might have inhomogeneous light distribution, but this will be improved once the shading correction has been performed.

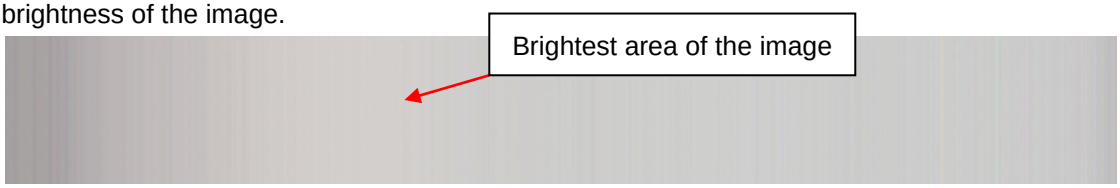
Please proceed to chapter 6.6.3

The allPIXA-manual contains details of all parameters of the CST - Camera Setup Tool. The “Getting started”-document contains only basic functions of the camera to get started with the 3DPIXA. For detailed information on other parameters, please refer to the allPIXA manual.

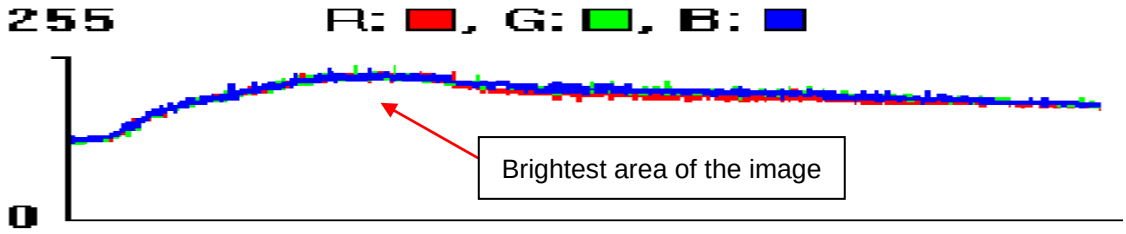
6.6.2.2 For 3DPIXA dual models

Step 1: Setup white reference mark position

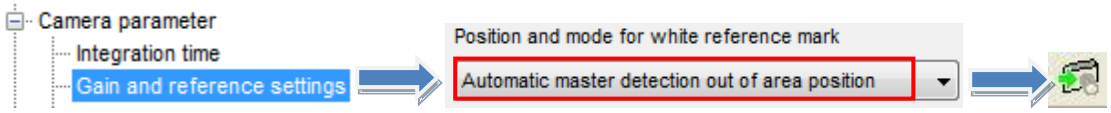
Observe a live image. A live image can be seen from your own application software or the software interface provided by the framegrabber manufacturer. The White reference mark should be set to the brightest area of the image. You may use a line profile to evaluate the brightness of the image.



This is how your image could look like. It can be seen that the brightest area of the image are at the positions, where the arrows are.



Set tap control to „Automatic master detection our of area position“



Activate “Display white reference borders in the image”

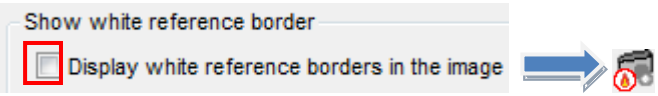
Your should see the white reference mark at the brightest area of the image. If not, adjust position of the white reference mark accordingly by following the steps below.

You should see a value in the following box, e.g. 1000

Type in a smaller value than the actual value into the red box and transfer setting into the camera  to make the reference mark move leftward (see illustrations below). The mark should be at the brightest area of the image.

Type in a bigger value than the actual value into the red box and transfer setting into the camera  to make the reference mark move rightward (see illustrations below). The mark should be at the brightest area of the image.

If the reference mark is at the brightest region of the image, disable “Display white reference borders in the image” and burn setting to camera  .

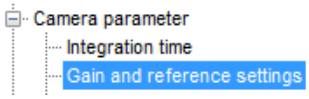


The two cameras of the 3DPIXA dual will have different positions, where the zone in the image is at its brightest. Adjust reference mark position accordingly for both cameras.

Step 2: Adjust the camera gain values

Adjust the gaining (amplification) values to achieve best image quality:

Get back to the „Gain and reference settings“

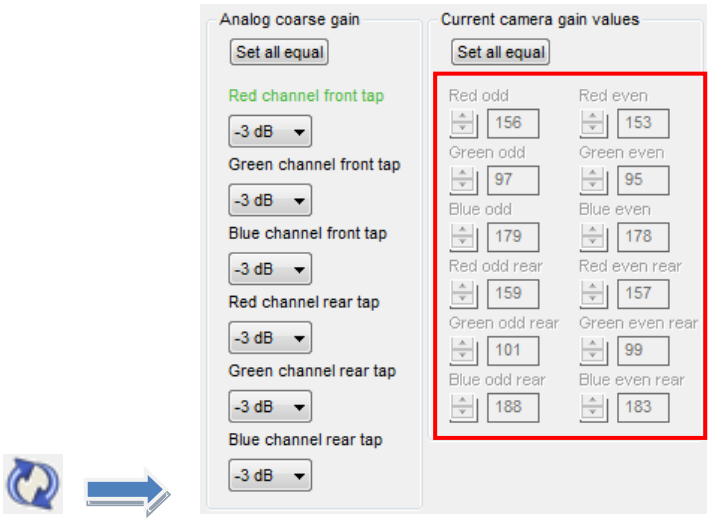


Enable „Continuous white control“

The signal amplification comprises of the two amplification levels: „Analog coarse gain“* and „Current camera gain values“.

The „Current camera gain values“ are recommended to be in the range of 80 – 200 (red box)

Click the  -Button and check the “Current camera gain values”.



1: If the current camera gain values are in the range of 80 – 200, you may proceed to step 3.

2: If the current camera gain values are higher than 200

→light up your illumination or

→increase integration time or

→increase analog coarse gain**

Then, click and . Check the “Current camera gain values” again.

3: If the current camera gain values are lower than 80

→decrease analog coarse gain** or

→decrease integration time or

→lower the intensity of your illumination

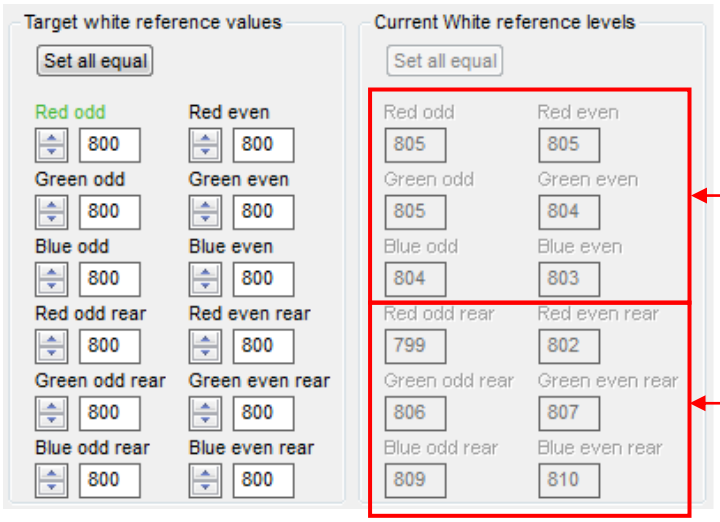
Then, click and . Check the “Current camera gain values” again.

**Analog coarse gain:

- pre-amplification factor: 1dB corresponds to 27.85 steps in “Current camera gain values”
- You can increase “Analog coarse gain” for all channels by changing the topmost value, clicking the “Set all equal”-Button then the -Button

Step 4: Save settings permanently

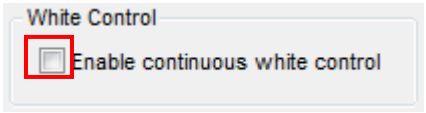
Check the “Current white reference levels”. They should be in the range of 770 – 830 (red box)



Check these values, if your white reference mark is on the **left** side of the image

Check these values, if your white reference mark is on the **right** side of the image

Disable “Continuous white control”



Perform tap balancing

Now the “Start gain values” should be the same as the “Current camera gain values”. The camera will start up with the “Start gain values” once the setting has been burned permanently into the camera by pressing the -Button

Your 3DPIXA is white balanced. Due to lens vignetting (shading), the image might have inhomogenous light distribution, but this will be improved once the shading correction has been performed.

Please proceed to chapter 6.6.3

The allPIXA-manual contains details of all parameters of the CST - Camera Setup Tool. The “Getting started”-document contains only basic functions of the camera to get started with the 3DPIXA. For detailed information on other parameters, please refer to the allPIXA manual.

6.6.3 Black referencing

Black offset correction should be done internally in the camera ([1] chapter 11.3) It is very important, that the black reference image acquisition is done after adjusting the camera gain values (white balancing) as the gain values influence directly the black offset. Therefore the black reference needs to be redone again, when the gain values are changed.

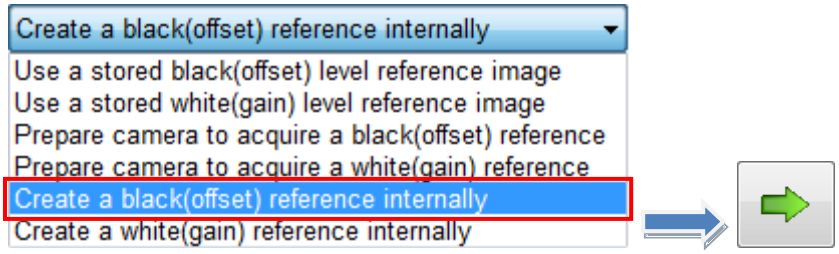
Note:

- White balancing should be done before the black level correction.
- Have the correct pre-setting: Disable encoder

Open the “Reference generation wizard” by clicking the -Button on the toolbar

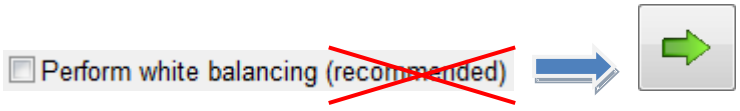
(The wizard)

Select “Create a black(offset) reference internally.



Disable “Performing White balancing”

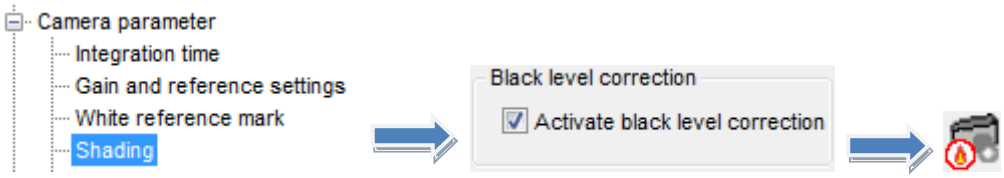
- For the 3DPIXA, it is not recommended to perform white balancing with the shading wizard
- White balance(chapter 6.6.2) should be performed before black level correction.



Cover the lens(es), then press “Next”

After the black reference has been generated successfully, click the OK -Button

Enable “Activate Black level correction” and save setting permanently into the camera by pressing the -Button.



The camera should have the correct offset value

6.6.4 Shading referencing

Shading correction is carried out after white balancing (6.6.2) and black level correction (6.6.3).

Acquire an image of your white reference that covers all ROI (see pre-setting chapter)

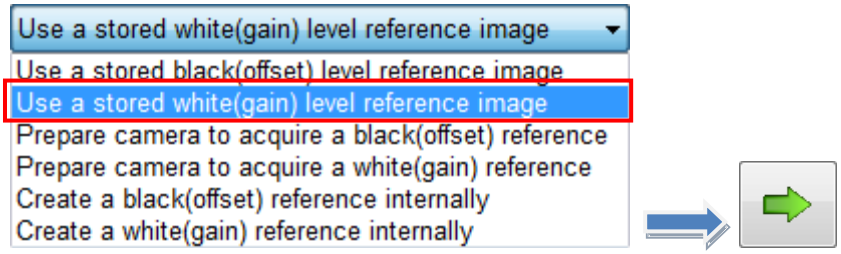
- The white reference shuold be at focus plane
- The white reference should move.
- Your image should has at least 1000 lines

After succesfully acquired the moving white reference = shading reference, follow the steps bellow.

Open the “Reference generation wizard” by clicking the -Button on the toolbar


(The wizard)

Select “Use a stored white(gain) level reference image”.



Select your shading reference image.

Click on Select file Select your shading reference image

A shading reference generation window will open.

a

- **Define the data set in which the offset-reference should be generated and stored**
  4 sets (1-4) of black reference data are possible

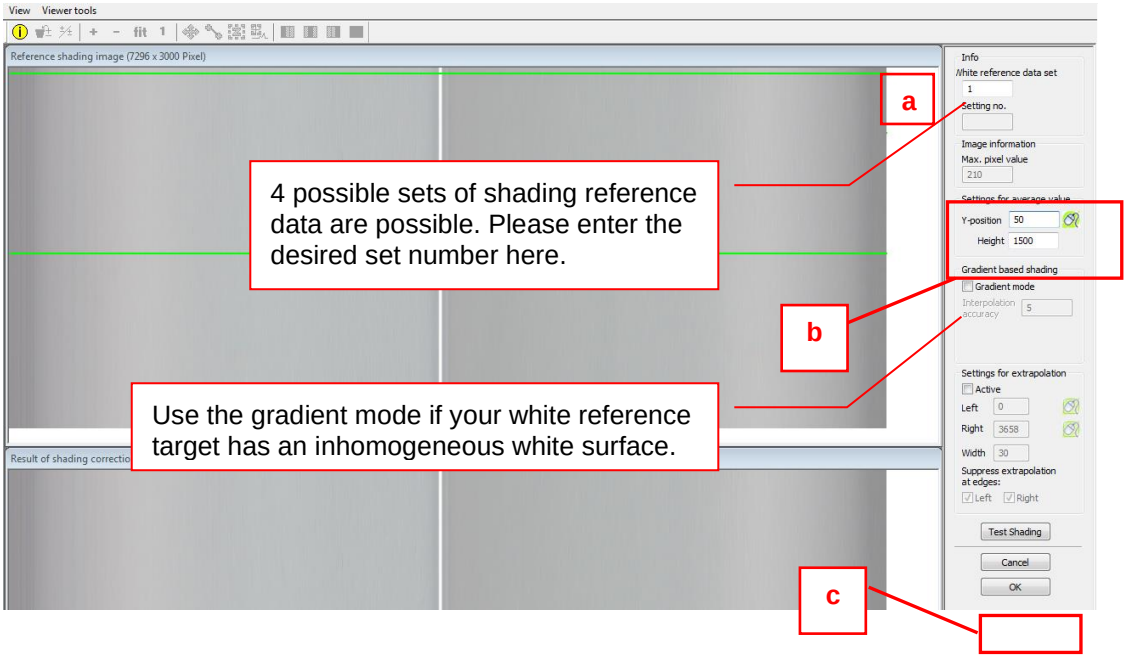
b

- **Set the area where the reference values should be calculated**
  Use at least 100 lines for calculating the reference values in order to eliminate noise.
  The values used for the reference will be calculated by averaging each column in the selected area.

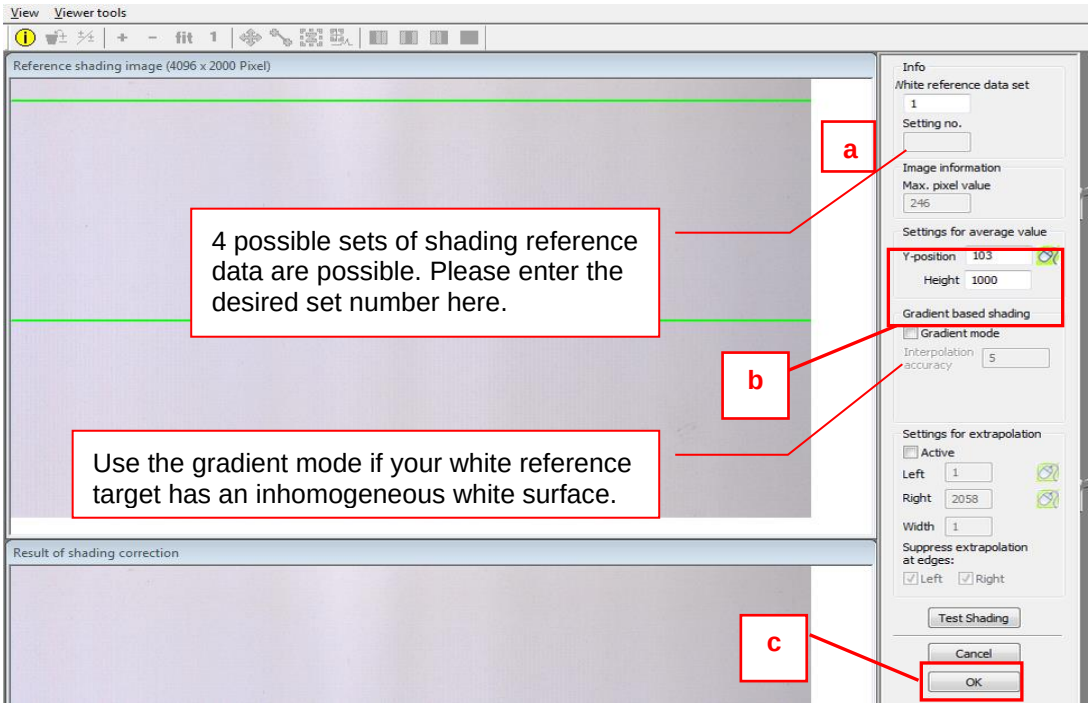
c

- **Press the “OK” button**

Sample image(compact):



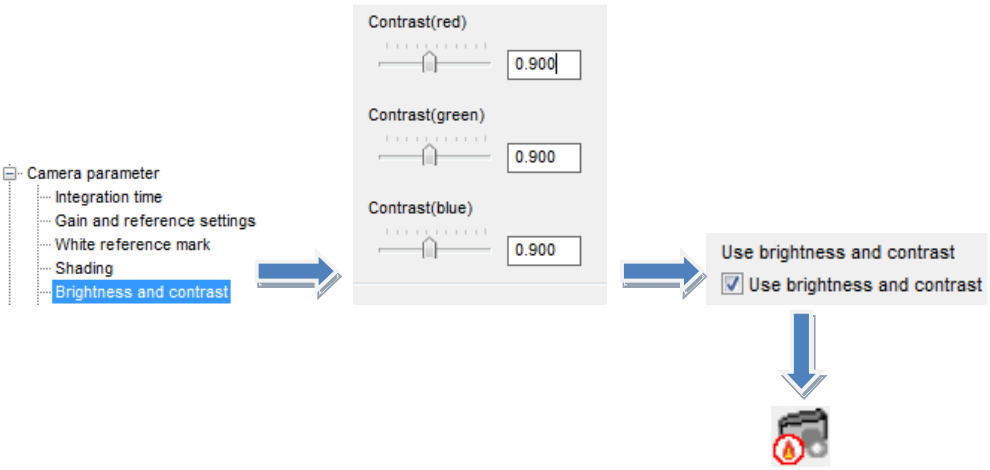
Sample image(dual):



Enable “Activate Shading correction” and save setting permanently into the camera by pressing the -Button.

Shading correction should be activated by now. Video value of all pixels should be at approx. 255 by now.

Recommended: Set contrast to 0.9 to avoid image saturation.



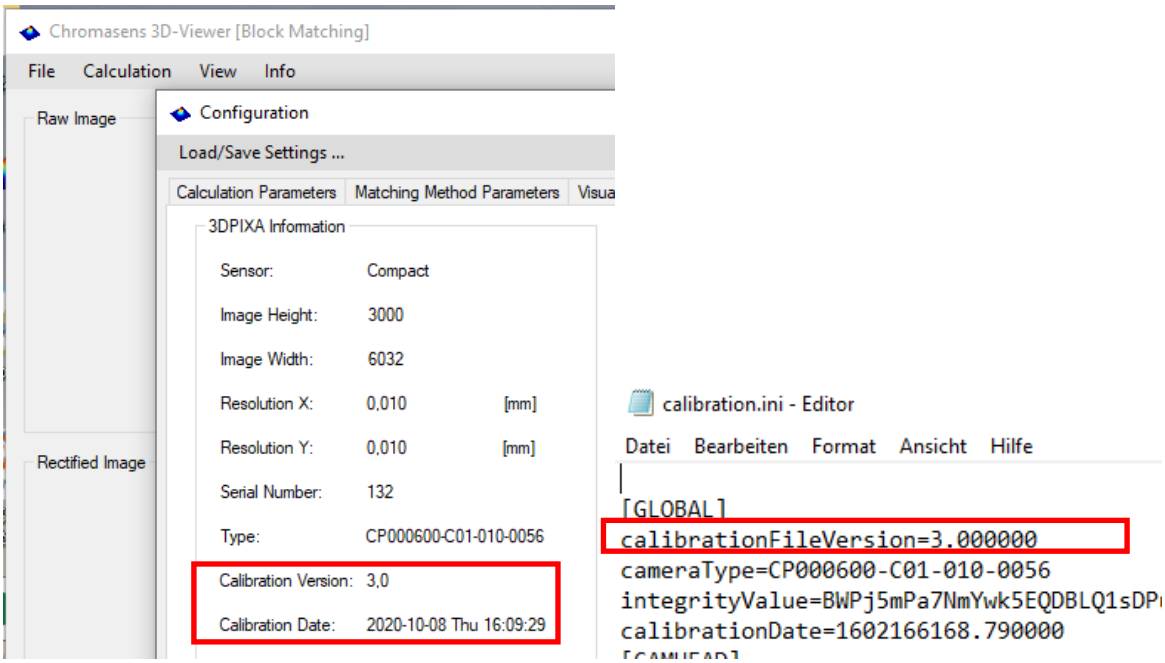
The allPIXA-manual contains details of all parameters of the CST - Camera Setup Tool. The “Getting started”-document contains only basic functions of the camera to get started with the 3DPIXA. For detailed information on other parameters, please refer to the allPIXA manual.

6.7 Verify Calibration

6.7.1 Precondition for verify calibration

Each 3DPIXA was exactly calibrated after being manufactured. If conditions or the environment change over time or due to stress during transport and installation, the original calibration may not provide the same accuracy as before.

Therefore, the calibration must be checked before operating. The 3D Viewer provides the possibility to validate the calibration for calibration version v2.0 or later. The calibration version can be found in the 3DViewer or the Calibration-File



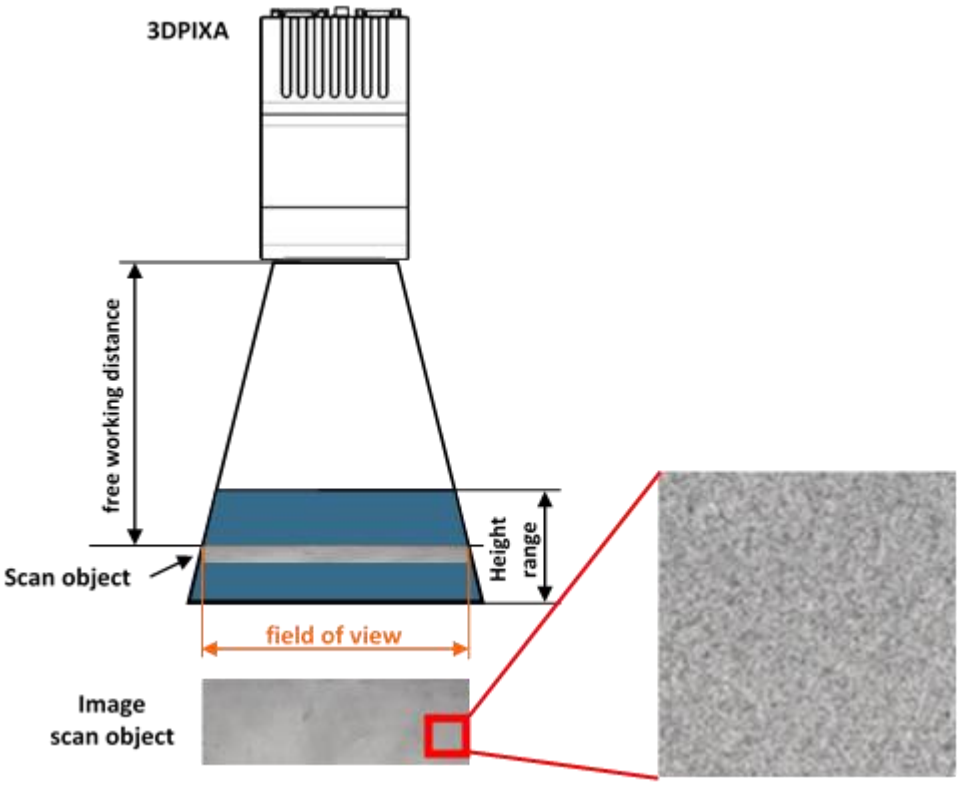
3DViewer / Calibration File

The verification process is based on detecting and matching some areas of raw images. The chosen raw images, respectively the scan object, should fulfil the following criterions. Otherwise, the verification may not work successfully.

a) The scan object must have a flat surface. Obvious height differences (e.g. from steps or slope) of the surface must be avoided.

b) Along the whole Field of View of the 3DPIXA, the images must be rich in recognizable textures, patterns or features.

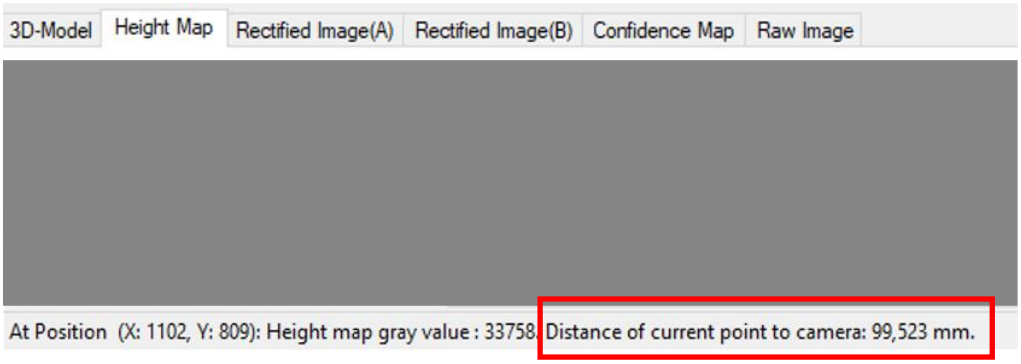
c) Proper image quality is required. The image must be sharp, scan object must be placed within the height range (at the free working distance). The image must be free of color fringes and saturation.



Example of positioning scan object (flat and sandblasted metal plate)

which results in a suitable raw image with texture used for calibration verification

To check the suitability of the images for the calibration verification, 3D data must be calculated in the 3D viewer. To ensure that image quality is suitable for calibration verification, it is advisable to use the 3D viewer to compute a height image and verify that objects in the image are in fact in focus. This can be done by moving the mouse over the height image and comparing the "Distance of current point to camera" measure from the status bar to the free working distance (FWD) of the camera model in use.



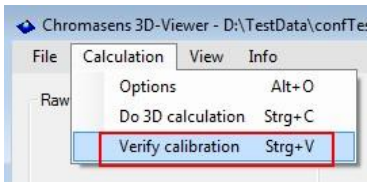
Height map with distance of current point to camera

Also, the planarity (i.e. if the surface is even) of the calculated surface should be evaluated visually by checking the 3D-Model view

3D Model of even 3D result.

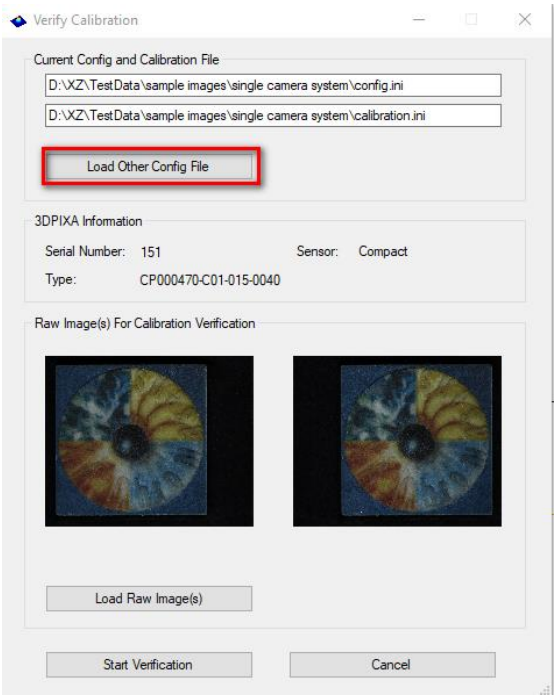
6.7.2 Perform verification process with 3D Viewer

The 3D Viewer provides the possibility to check the validity of the calibration. The dialog of verifying calibration can be opened by clicking the menu bar “Calculation” and then “Verify calibration”, or by using the hotkey “ctrl+v”.

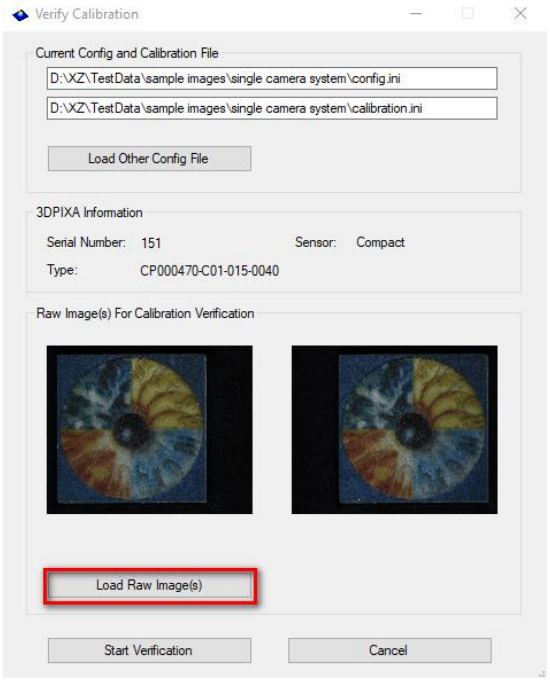


Step 1: choose a configuration file, whose corresponding calibration file should be verified.

By opening the “Verify Calibration” window, the current loaded configuration file will be used for verification by default. If a different configuration file should be used, the user can click the button “Load Other Config File” The file path of the chosen configuration and calibration file will be shown above in text field, and the corresponding camera information will be displayed in the middle area.



Step 2: choose raw image(s) which will be used for calibration verification.



By default, the current loaded raw images will be directly ready for the following verification. The user can pick other raw images for calibration by clicking the button “Load Raw Image(s)”.

Step 3: start verification

After loading raw image(s), the verification can be started by clicking the button “Start Verification”. The verification will last several minutes. One of the following results will be shown after the verification

a) Calibration verification is done successfully.

   The current calibration is valid. There is no need to adjust the calibration

b) Calibration verification is not successful.

   Most probably because the chosen image(s) are not suitable for verification due to too few features or texture in the raw image. The user can then choose new raw images or cancel the verification

c) Calibration is not valid anymore.

   This indicates that the calculation based on the calibration is not reliable. So the calibration should be adjusted. The user can choose to adjust and **overwrite** the current invalid calibration file or to cancel and quit the verification process. The adjustment of calibration will also last several minutes, In the end, a result of adjustment will be informed as well.

Troubleshooting

If you are not able to perform the verify calibration with the information in this document, please contact Chromasens technical support for further help. support@chromasens.de.

6.7.3 Tested Framegrabbers

The compatibility of the 3DPIXA with the following CameraLink Framegrabbers is tested:

- Euresys
  - GrabLink Full
- Matrix Vision
  - mvHYPERION-CLm
  - mvHYPERION-CLf
- Matrox
  - Matrox Solios eV-CL
  - Matrox Radient eCL
- National Instruments
  - NI-PCIe-1433
- Basler / Silicon Software
  - microEnable IV AD4-CL
  - microEnable IV VD4-CL
  - microEnable marathon V
- Dalsa Correco
  - X64 Xcelera-CL PX4 Dual
  - X64 Xcelera-CL PX4 Full

6.8 Compatible GPU

In general, every ≥ 3.0 CUDA capable NVidia GPU with ≥ 2 GB RAM upward can be used.

Calculation speed of the 3D data depends on the GPU used for your 3DPIXA application.

The following GPUs were tested for their compatibility:

Not compatible:

- NVidia GTX 285
- NVidia GTX 480
- NVidia GTX 580

Compatibility tested:

- NVidia GTX 680
- NVidia GTX 770
- NVidia GTX 780 TI
- NVidia GTX Titan
- NVidia GTX 980
- NVidia GTX 980 TI
- NVidia GTX 1080
- NVidia GeForce GTX 1080 Ti

Generally, all models which support the necessary CUDA versions work.

RTX 16XX (Ti), RTX 2XXX (Ti), RTX 3XXX (Ti).

- NVidia GTX 1650
- NVidia RTX 2060
- NVidia RTX 3070

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