

# **truePIXA | Getting Started**

**CD40154 Version 2.1**

## Table of Contents

<b>1</b>	<b>About Chromasens</b>	<b>4</b>
1.1	Contact Information	4
1.2	Support	5
<b>2</b>	<b>About color measurement</b>	<b>6</b>
2.1	Multi-channel camera vs. true color measurement	6
2.2	Point measurement spectrometer vs. true color imaging	6
<b>3</b>	<b>Components required</b>	<b>8</b>
3.1	Hardware	8
3.2	Software	10
<b>4</b>	<b>Mechanical Installation</b>	<b>11</b>
4.1	First steps for mounting the truePIXA	12
4.1.1	Transport system	12
4.1.2	Camera angles and scan direction	13
4.1.3	Working distances for truePIXA	15
4.2	Mechanical installation of truePIXA with Corona II light	18
4.2.1	Using a roller or a conveyor	20
4.2.2	Using a mirror	22
4.2.3	Mounting several truePIXA	<b>Fehler! Textmarke nicht definiert.</b>
4.2.4	White reference	24
4.3	Connections	24
4.3.1	Connect the XLC4 controller	25
4.3.1.1	Connect the computer	25
4.3.1.2	Connect the power supplies ()	26
4.3.1.3	Connect the Cooling System	26
4.3.1.4	Connect the illumination Corona II D50	26
4.3.2	Connect the truePIXA	29

4.4	Setting up the XLC4 controller	30
4.4.1	Connecting the XLC4-controller	31
4.4.2	Switch on the fan	31
4.4.3	Setting up the current level	32
<b>5</b>	<b>Setting up the truePIXA</b>	<b>34</b>
5.1	Setting up the illumination angle based on the signal	34
5.2	Gain and target reference value settings	35
5.2.1	Preparations	35
5.2.2	White reference mark	37
5.2.3	Gain values	39
5.2.3.1	Basic setup to start the gain settings	39
5.2.3.2	Setting the target white reference values	40
5.2.3.3	Setting the analog coarse gain	43
<b>6</b>	<b>Calibration</b>	<b>45</b>
6.1	Dark offset correction	45
6.2	Geometry Calibration	45
6.3	Color Calibration	47

## 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.

### 1.1 Contact Information

#### **Chromasens GmbH**

Max-Stromeier-Str. 116

78467 Konstanz

Germany

Phone: +49 (0) 7531 / 876-0

Fax: +49 (0) 7531 / 876-303

Email: [info@chromasens.de](mailto:info@chromasens.de)

## 1.2 Support

### **Chromasens GmbH**

Max-Stromeyer-Str. 116

78467 Konstanz

Germany

Telephone: +49 (0) 7531 / 876-500

Fax: +49 (0) 7531 / 876-303

Email: [support@chromasens.de](mailto:support@chromasens.de)

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

## 2 About color measurement

### 2.1 Multi-channel camera vs. true color measurement

If one is used to do 'simple' inspection using gray scale or RGB cameras, **truePIXA** is the consequent extension from RGB (3 channel) to a 12 channel system, whereas the channels of the system are optimized to cover the visible spectral range. Applications where the three RGB channels are not sufficient (e.g. color separation in general terms), can be treated with **truePIXA**. Within the application **truePIXA** offers the extension of color image processing from three to twelve channels. In this case system stabilization and especially the design of the illumination does not differ compared to any imaging system used for inspection.

On the other hand, if the system is used for high quality color control, every component must be well defined, controlled and especially stabilized to guarantee the short term, long term and absolute color precision of the measurement system. Any measurement cannot provide higher precision and quality as the general setup provides. The weakest point within the design will always limit the general performance. Therefore no technical point of the whole system can be thought as insignificant, unless it is proven explicitly.

### 2.2 Point measurement spectrometer vs. true color imaging

Standard color measurement devices used in industry are point measurement instruments. Typically the sample's surface is illuminated circular under 45° [ISO 13655]. The diffuse remission of the surface is measured at 0°, and spectrally resolved using a diffraction grating. The diameter of the aperture is typically about 2.5mm – 4mm. One measurement lasts roughly 1 second. That corresponds to a measured area of 5-12 mm<sup>2</sup> per second. A typical configuration of **truePIXA** operates up to transport speeds of 5.5m per second with a scanning width of 250mm. That corresponds to a measured surface of 1 375 000 mm<sup>2</sup> per second.

That simple calculation is made to give an impression about the strength, and great advantage of **truePIXA**. Additionally the system provides a freely tunable ROI size, shape and position.

The latest standard devices for color measurement are handheld devices. We compare the absolute (color-) agreement of **truePIXA** with those standard devices.

The typical performance in an optimal system is:

- Mean  $dE_{76} = 1.2$  (measured on 100 HKS-samples)
- Short term repeatability = 0.04  $dE_{76}$  (mean value 10 measurements on white)

To give a relation to typical inter-instrument agreement among handheld devices of different manufacturers, we compared 4 instruments of the latest generation. We found that their agreement is in the range of 0.9-1.1  $dE_{76}$  measured on the 100 HKS samples. We deduce that our imaging color measurement is in the same precision range as those typical handheld spectrometers.

The first time standard image processing tools and true color measurement are combined within one system. For example image segmentation can be used to find freely shaped connected areas, which are used for color control within the image. Spatially continuous color changes can be monitored on the whole specimen.

Machine independent color-mastering can be done to do global color matching. To guarantee 100% color control and color monitoring, all image based: use **truePIXA**.

### 3 Components required

#### 3.1 Hardware

- ✓ **truePIXA** camera (shipped)

Moving stage/Conveyer:

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

Optional: Lifting Table

- Fine scale lifting table might be needed to place the object at the best focus plane of the **truePIXA**. Your object can be placed at the best focus plane of the camera. Moreover it's important that the sample and the white reference are on the same level.

Camera Link frame grabber(s)

- 1 x medium frame grabber or 1 x base frame grabber is required per **truePIXA** camera. In situations where multiple **truePIXAs** are being used, the number and type of frame grabbers should be selected accordingly. Dependent on required scanning speed, **truePIXA** can be operated in base or medium mode.

Line Scan Illumination (Can be ordered on request)

- Chromasens manufactures its own high quality line scan illumination "Corona II" with extremely bright and homogeneous light. The D50 LED line light source has been specially designed for color measurement with **truePIXA**. This light is also available in various dimensions, foci, cooling systems, darkfield and tubelight variations. Please contact us for further information about our line scan illumination varieties.

Camera Link Cables:

- 2xCamera Link cables per camera in medium mode
- 1xCamera Link cable per camera in base mode

The **truePIXA** provides **MDR connectors**. Check the connectors of your frame grabber in order to decide, if you need MDR-MDR or MDR-SDR Camera Link cables.



Power supply:

- 1xPower cable Hirose 6-pin plug “female” 24V(HR10A-7P-6S) per camera. (Can be ordered on request)

Optional: Encoder/Light barrier

- Encoder - Line trigger (LVAL)
- Light barrier - Frame trigger (FVAL)

PC with correct configuration setting

- System: Windows 7 x 64bit/Windows 8 x 64bit
- Quad Core >2,20 GHz
- Memory >4GB RAM
- Optional for using truePIXA API – Development environment C++ (Microsoft Studio 2010 is recommended)
- Power-supply, enough for truePIXA, Corona II, XLC4, Encoders, PC with GPU, motor control, any other accessories e.g. water cooling system.
- A complete list of system requirements for truePIXA is available. Please check the truePIXA system requirements document for more information

Chromasens color calibration chart (Must be ordered from Chromasens)

- This special color chart is necessary for the color calibration of the **truePIXA**.

Chromasens geometry calibration chart (Available in the partner area of the [Chromasens homepage](#))

- This special chart is necessary to correct the objective shifts.

Chromasens white reference (Can be ordered from Chromasens)

- This white reference offers the best light scattering properties for perfect shading.

### 3.2 Software

The required software is available in the partner area of the Chromasens homepage

- Chromantis software (For color measurement and calibration)
- truePIXA API
- CST Camera Setup Tool software (For setting basic camera parameters)
- XLC4 Commander (For setting up the light source)
- CS API (For setting the camera parameters)

**NOTE:** The functions of the Chromasens Chromantis software will be explained in chapter [6](#). The direct connection between Chromasens Chromantis and the frame grabber is usable only with a MATRIX VISION frame grabber. Otherwise, the raw images could be saved with external software and processed by drag and drop in Chromantis.

## 4 Mechanical Installation

Before doing the mechanical installation, there are several important points to know. This will help you save your time and efforts in mounting the system precisely.

- Do not touch and try to clean the optical filters on the front side of the truePIXA camera. Any dust particles, scratches or fingerprints will affect the color measurement and image quality drastically.
- Handle with extreme care and do not open the front adapter of the camera.
- The position of the truePIXA with respect to the illumination is very critical. A change in the truePIXA angle to the illumination and vice versa will lead to inaccuracies higher than  $\Delta E 5!$  Therefore, it is strongly recommended to mount the truePIXA and illumination on a single frame.
- It is important to carry out the calibration procedure on a flat moving table. Rollers or cylinders are not suitable for calibration! Once the system is calibrated on a flat table, it can be mounted undisturbed on a roller at the same working distance as on the calibration table. In this case it is necessary that the camera looks exactly perpendicular to the roller.
- The color and geometric calibrations will only work if the truePIXA and Corona II are calibrated together (as shown in [Figure 5](#)). Once the camera and light are calibrated together as a single color measurement system, they should not be disturbed. In case where the truePIXA and light are demounted from a calibration table and moved to a completely new location (e.g. roller) and fixed individually, the calibration will likely not work!! Any changes demand recalibration of the system.
- The working distance of the camera should be carefully adjusted according to the provided mechanical drawing before doing the camera settings. The working distance during calibration and on the machine must be the same (max. tolerance  $\pm 0.25$  mm).
- The aperture shown in the images below must be as close to the object surface as possible. Remember the reflected light from object surface should go through the aperture, not the light from the illumination! (as shown in [Figure 5](#))
- A second aperture can be used close to the camera but this is optional in most of the cases (as shown in [Figure 5](#)).

## 4.1 First steps for mounting the truePIXA

### 4.1.1 Transport system

First of all it's important to prepare your moving stage, roller or conveyor (e.g. conveyer/linear table). Please keep in mind that the calibration only can be performed on a flat surface.

- Check for stable movement of your moving stage/roller/conveyor.
- The maximum movement speed depends on the selected camera resolution (see [Table 2](#)).
- The width of the inspection area depends on the selected field of view (see [Table 2](#)).
- Make sure, that there is enough space between the inspection area and the camera (free working distance), to reach the observed working distance. Take into account, height of object.
- Because of the limited depth of field and the height dependent geometrical calibration of the truePIXA camera only flat objects can be scanned. Height changes lead to a relative shift of the sub-images.
- There must be enough room to install the illumination at an angle of 45° to the inspection area. The illumination distance depends on the selected illumination type (see [Figure 5](#)).
- Please check the Corona II manual to find the right working distance for your illumination type. The Corona II manual is available in the partner area of the [Chromasens homepage](#).
- 

**NOTE:** See [Table 2](#) to find the correct working distance, field of view and maximum movement speed for your truePIXA camera.

#### 4.1.2 Camera angles and scan direction

- The sensor line should be adjusted perpendicular (90°) to the transport direction

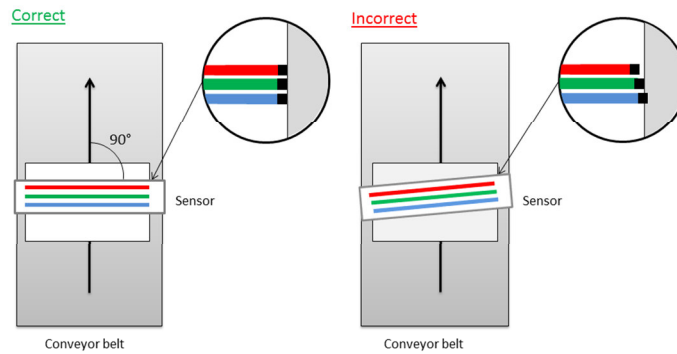


Figure 1: Perpendicularity of the camera to the transport direction

- The camera's longitudinal and transverse axis should be perpendicular (90°) to the inspection area

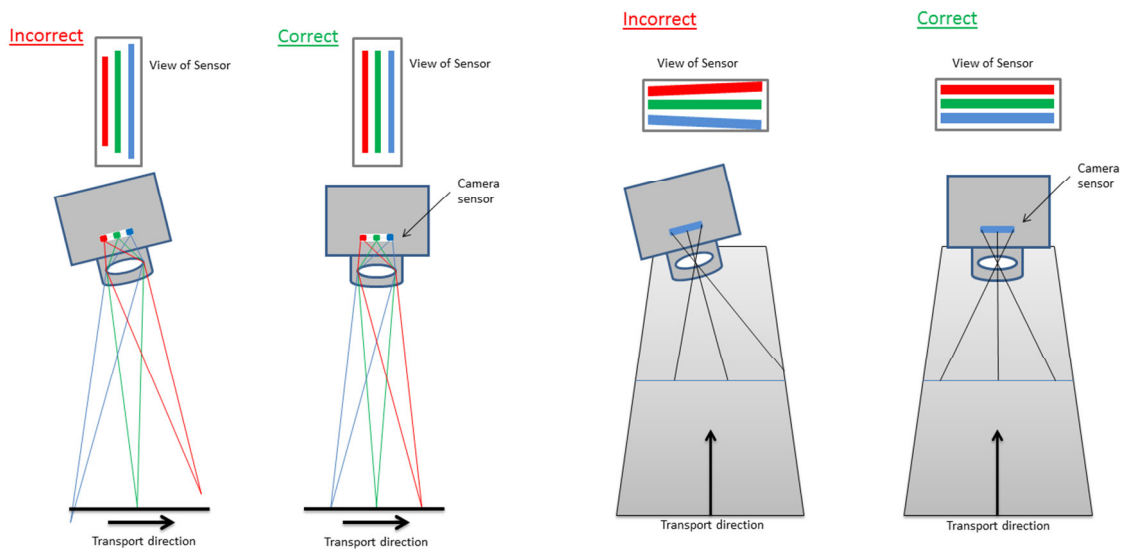
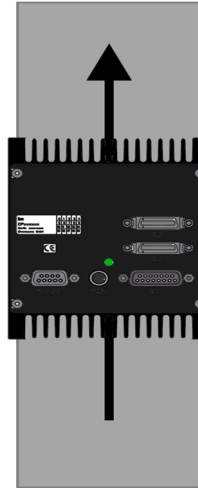


Figure 2: Perpendicularity of the camera to the inspection area

- Make sure the camera is not tilted.

- The forward scan direction is as illustrated in [Figure 3](#) below.



*Figure 3: Forward scan direction for the truePIXA*

- It is possible to scan in both directions. The scan direction can be changed in the provided software (CST).
- Mount your truePIXA at the correct working distance. The working distance for your truePIXA model is provided to you by Chromasens GmbH in [Table 2](#).

### 4.1.3 Working distances for truePIXA

- The working distance for truePIXA is defined by the optical configuration, lens type, number and type of filters, resolution, length of sensor and scanning width.
- It's very important to observe the specified working distance with a tolerance of  $\pm 0.5\text{mm}$ .
- For calibration and measurement must be used exactly the same working distance.

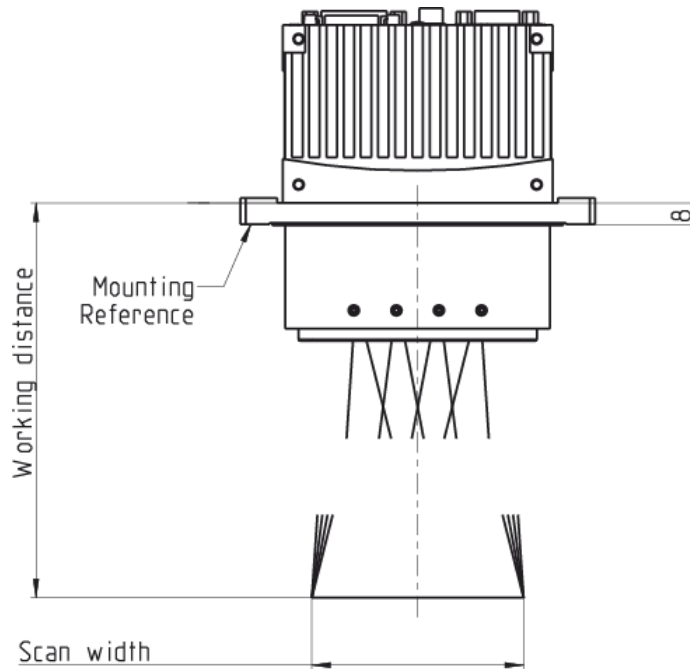


Figure 4: Working distances for the truePIXA

The following table shows all the product variants of truePIXA. The product key contains all parameters of each camera. Please read the working distance for the corresponding resolution from [Table 2](#).

The following tables describe the product key and show the parameters of all cameras.

Basic identification number		Variant		Variant	Objective type		Resolution (µm)		OEM signing
		ID1		ID2	ID3		ID4		ID5
CP000518	-	06	-	C	01	-	130	-	-

Table 1: Description of the product keys in Table 2

Product-#	truePIXA Version	Sensors (Cam Link)	Resolution		FOV	WD (working distance) ±0.5mm*	Vmax	Recommended illumination length
		[#]	[µm/pixel]	[dpi]	[mm]	[mm]	[m/s]	[mm]
CP000464-C01-043	truePIXA compact	1x7k	600	43	975	1544.43	12.7	1360
CP000464-C01-050	truePIXA compact	1x7k	503	50	820	1303.00	10.6	1020
CP000464-C01-090	truePIXA compact	1x7k	282	90	450	750.45	5.9	680
CP000464-C01-100	truePIXA compact	1x7k	254	100	405	679.99	5.3	680
CP000464-C01-130	truePIXA compact	1x7k	195	130	298	532.79	4.1	340
CP000464-C01-150	truePIXA compact	1x7k	169	150	245	468,82	3,5	340
CP000464-C02-200	truePIXA compact	1x7k	125	200	165	517.48	2.6	340
CP000464-C02-300	truePIXA compact	1x7k	84	300	126	374.05	1.7	340
CP000464-C02-423	truePIXA compact	1x7k	60	423	90	288.14	1.2	340
CP000518-06-C01-130	truePIXA pro 6c	1x4k	195	130	298	532.79	9,9	340

Table 2: Working distances for the truePIXA

\*The values in the [Table 2](#) are rounded values which would be a good reference on working distances for all truePIXA models. Please keep in mind that the field of view can be reduced by a change in the recommended working distance.



Points to remember while selecting the field of view:

- The widths mentioned above and in [Figure 4](#) denote the field of view required for real image area.
- However, please discuss with your contact at Chromasens while considering different truePIXA models for your application

#### 4.2 Mechanical installation of truePIXA with Corona II light

- From ISO 13655 the geometric configuration of illumination and observation is explicitly defined to 45°- 0° geometry, just the diffuse back scattered light should be measured.
- The illumination distance depends on the chosen illumination type (all types can be found in the Corona II manual).
- For calibration and measurement recommended using a black box with an optical aperture to avoid stray light.
- For color measurement we recommended a Chromasens Corona II type D50 illumination and a wide focus.

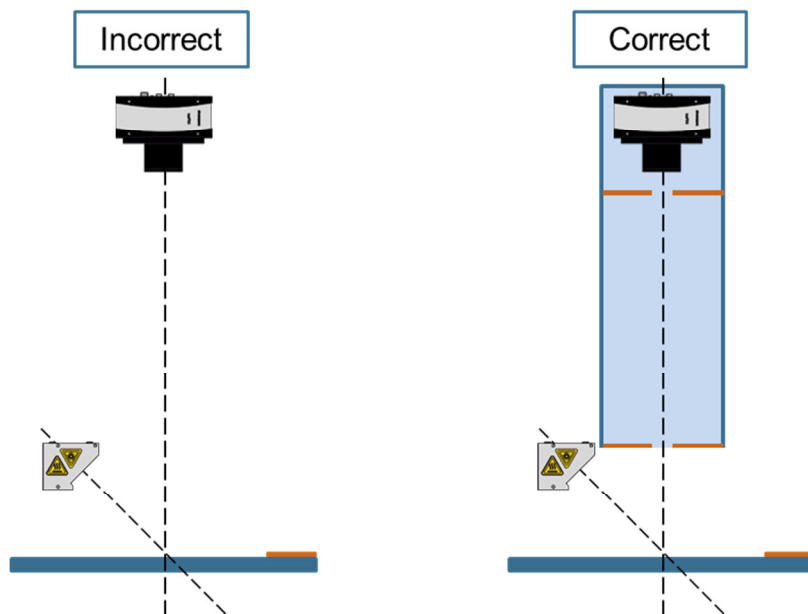
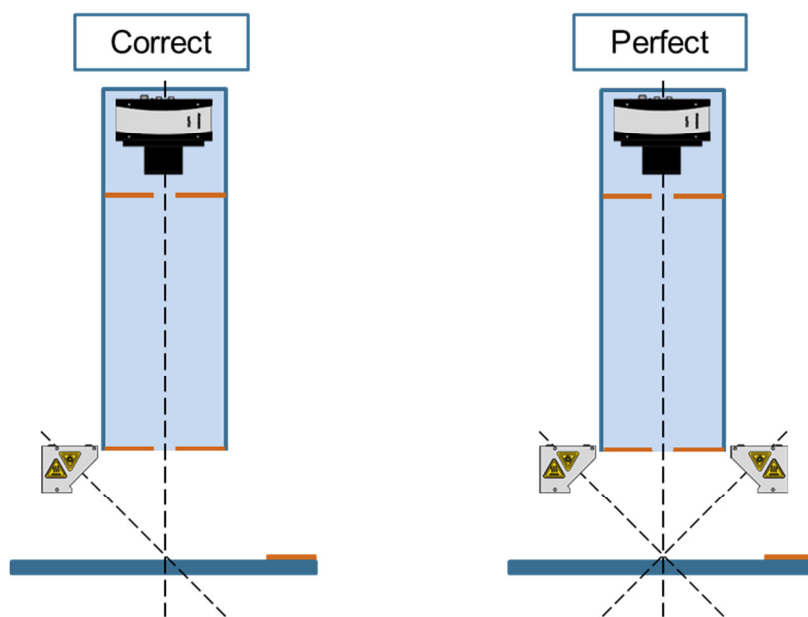


Figure 5: Cut the scattered light through a black box with optical aperture

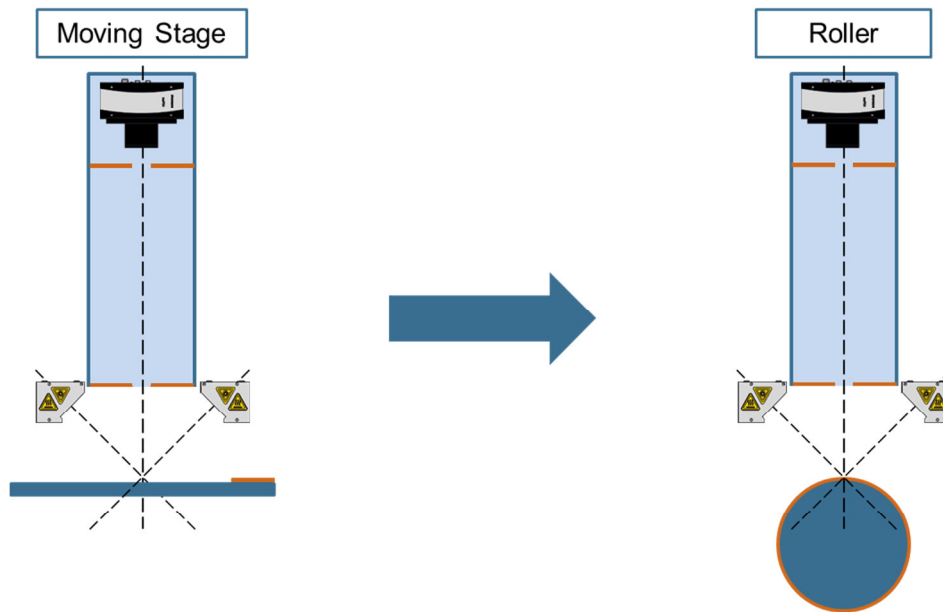
- The precision of the measurement can be improved by a large amount of light. Therefore, the accuracy is increased by two illuminations.
- Particularly in the case of high speed or high resolution (100dpi), the amount of light has a great effect on the accuracy of measurement.
- Rough surfaces produce shadows that can be eliminated by the use of two Corona II D50 line lights.



*Figure 6: Lighting the sample from both directions*

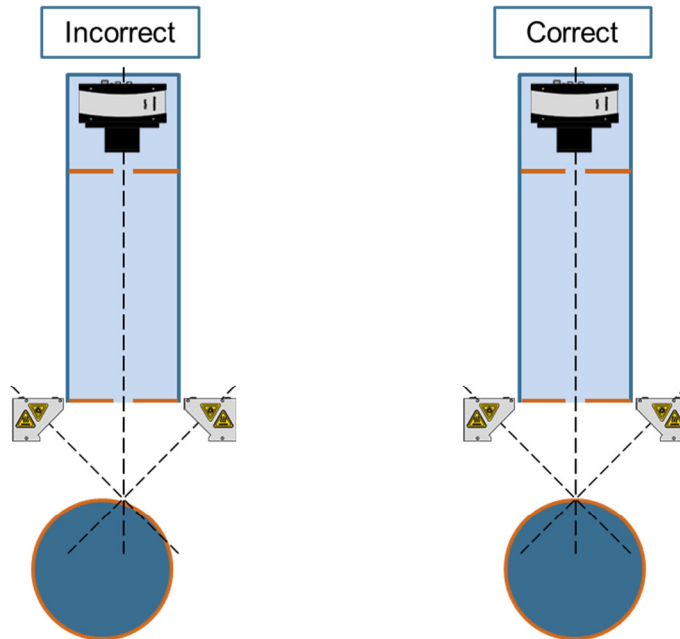
#### 4.2.1 Using a roller or a conveyor

- The calibration must be done on a flat surface like a moving stage.
- After calibrating on a flat table, the camera, light along with the frame can be mounted at the defined working distance on a real application like roller or a conveyor.



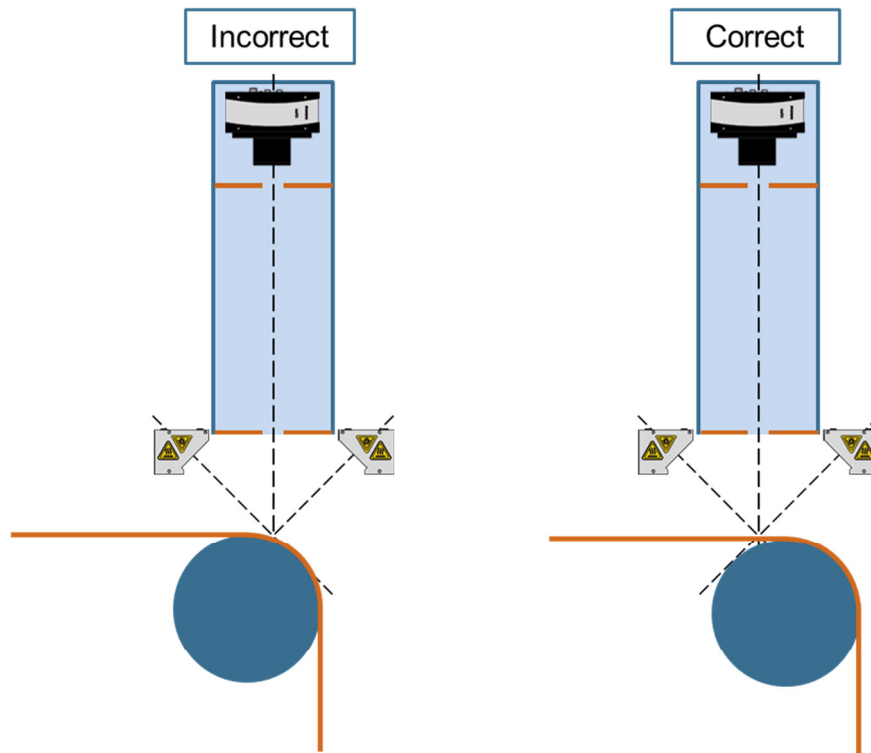
*Figure 7: Calibration steps for using a roller*

- If you are using a roller or a conveyor, the accurate positioning is very important.



*Figure 8: Correct positioning on a roller*

- In case of a conveyor for print inspection the truePIXA camera can be pointed on flat part of the transport system.



*Figure 9: Correct positioning on a conveyor for print inspection*

#### 4.2.2 Using a mirror

- The mirrors must be fixed accurately inside the frame as the angle of mirror to camera and light is extremely important.
- The surface of mirror must be smooth, consistent and not have any type of aberrations.
- The surface should not have any cracks and dust particles. Dirt could potentially affect the measurement.
- Please don't use a curved mirror.
- The size of the mirror is determined by the position in the optical system between the object and camera.
- Only first surface mirrors are suitable due to high optical requirements of color measurement.
- In case, mirrors are used in the setup, the calibration must be done along with the mirror in fixed position. The rule of using a flat table for calibration is valid for all conditions.
- Stray light must be carefully blocked when using mirrors

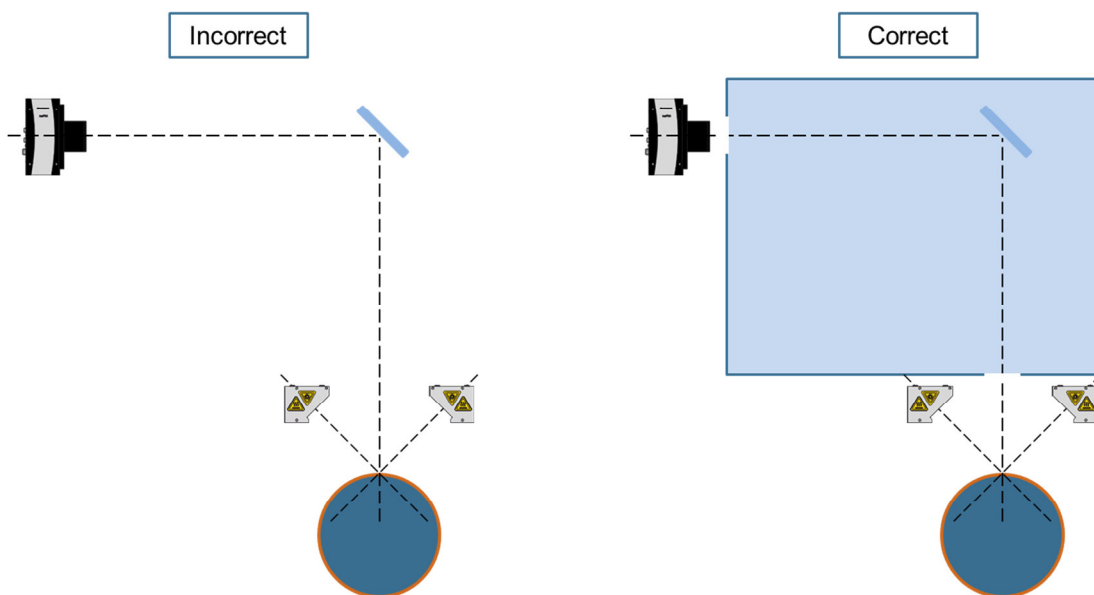
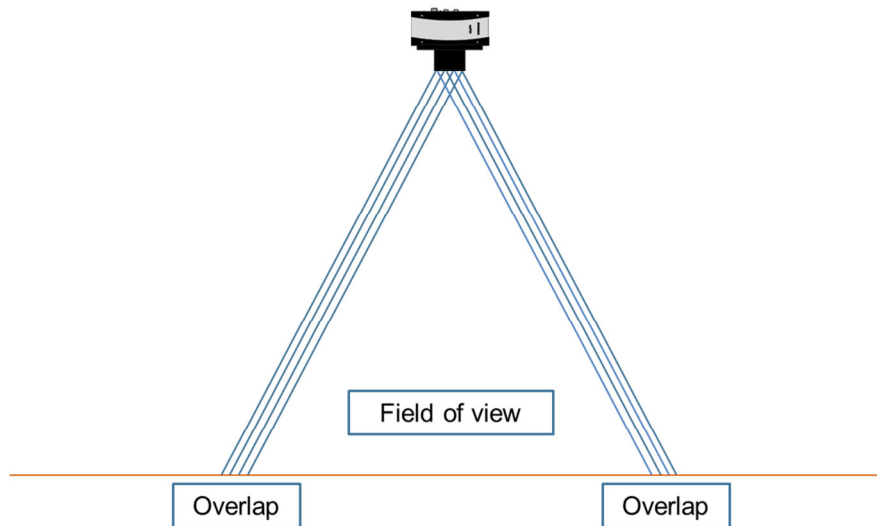


Figure 10: Correct arrangement in the use of a mirror

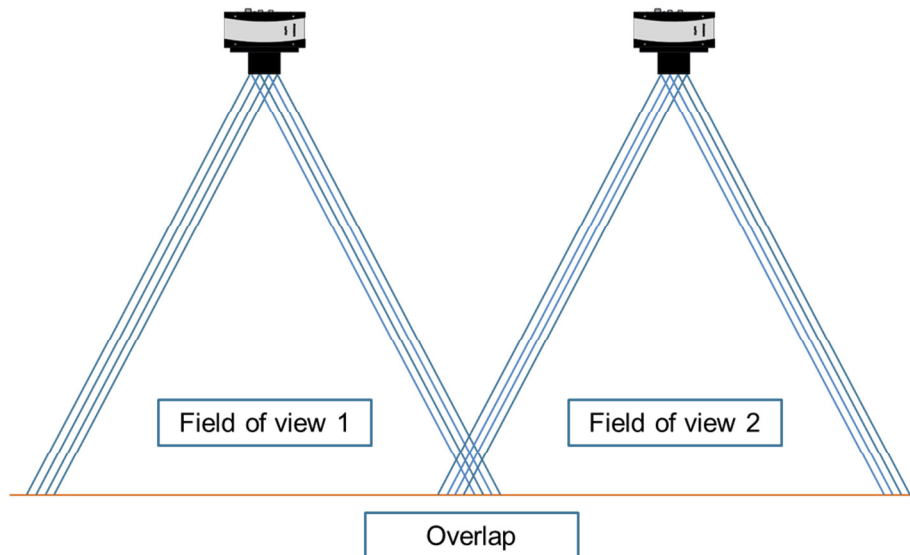
### 4.2.3 Overlap regions

The field of view of a truePIXA camera consists of an overlap of four objectives (sub-images). The geometry calibration matches the images to receive a multispectral image.



*Figure 11: Overlap region of the truePIXA camera*

In the case of using more than one truePIXA camera please make sure there is enough overlap between both fields of views (see [Figure 12](#)).



*Figure 12: Overlap region for using more than one truePIXA camera*

#### 4.2.4 White reference

- It is not important for the white reference to be within the field of view.
- The white reference can anyway be placed outside this region within the tolerance shown in [Table 2](#).
- The white reference must be on the same level as the sample.
- Depending on the position of the white reference the position of the white reference marks in CST has to be adapted (see section [5.2.2](#)).

The truePIXA white reference sheet is available in different sizes:

Base number	Size (mm)
CP000485	20x1000
CP000486	50x1180

*Table 3: Base numbers of different white reference sizes*

#### 4.3 Connections

The next chapter shows step by step, how to connect the truePIXA camera, the Corona II D50 line light and the XLC4 controller.



#### 4.3.1 Connect the XLC4 controller

The XLC4 controller is the center of the illumination system. On the front side of the controller are ports for the power supply, the connection to the cooling system and the computer.

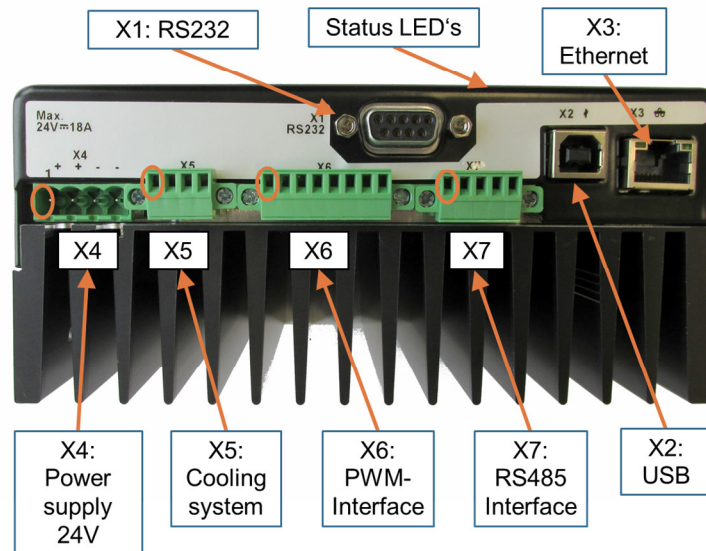


Figure 13: Various ports of the XLC4

**NOTE:** Please wait for the green status LED after connecting the power supply.

##### 4.3.1.1 Connect the computer

- RS 232 (X1)
  - We suggest using RS232-serial interface (X1) to connect the XLC4-LED controller to the computer if RS232-serial port is available.
  - If no RS232-serial port is available, use RS232-USB converter with FTDI chipset to connect the XLC4 with the computer.
- USB (X2)
  - If using USB, Install pic32mx\_usb\_v1.04.exe to a destination folder on your PC. This program can be found in the following directory: [USB-Stick]\Illumination\Drivers\USB-Driver. Copy mchpcdc.inf to the same destination folder pic32mx\_usb\_v1.04.exe was installed. A virtual COM-port should have been generated. You may connect to the XLC4 as stated below.

- Ethernet (**X3**)
  - If using Ethernet, please set a static IP address to the computer.

**NOTE: If using a USB to Serial converter for the connection via RS 232, please use one with an FTDI Chipset (Prolifix chipsets did generate problems while connecting to the camera).**

#### **4.3.1.2 Connect the power supplies ()**

- Power supply for the XLC (**X4**)
- Maximum voltage for the truePIXA camera and the XLC4 controller is 24V.

#### **4.3.1.3 Connect the Cooling System**

- If you use the fan cooling system, please connect the fans with the XLC4 controller (**X5**).
- An external liquid cooling system cannot be connected with the XLC4 controller and needs an own power supply.

**NOTE: For more detailed information about the PIN-configurations and the connection to the computer, please download the XLC4 manual in the partner area of the Chromasens homepage.**

#### **4.3.1.4 Connect the illumination Corona II D50**

- Only use this chapter for connect the Chromasens Corona II D50 illumination, otherwise see the Corona II manual in the partner area of the [Chromasens homepage](#) to find the right configuration.
- On the back side of the controller are the connection ports for the illumination, namely **X8, X9, X10 and X11**.

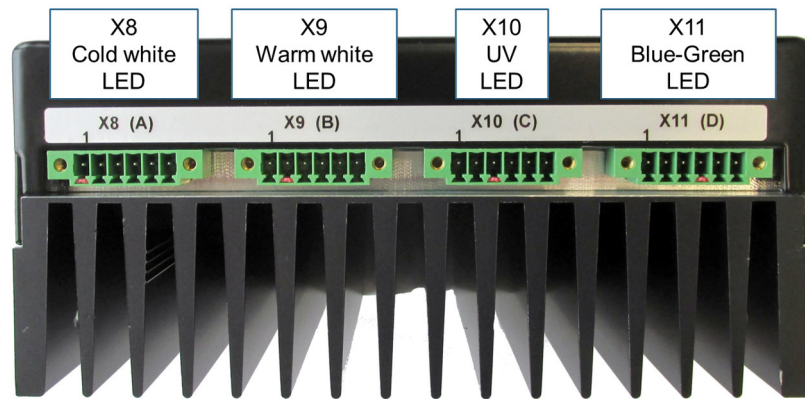


Figure 14: Communication ports on the XLC4

- While using the **D50** light source, it is important to respect the following order:
  - channel 1 (**X8**) – cold white LED
  - channel 2 (**X9**) – warm white LED
  - channel 3 (**X10**) – UV LED
  - channel 4 (**X11**) – blue-green LED
- Connect your Corona II **D50** illumination to **X8-X11** of the XLC4-LED controller as shown in [Figure 14](#) above.

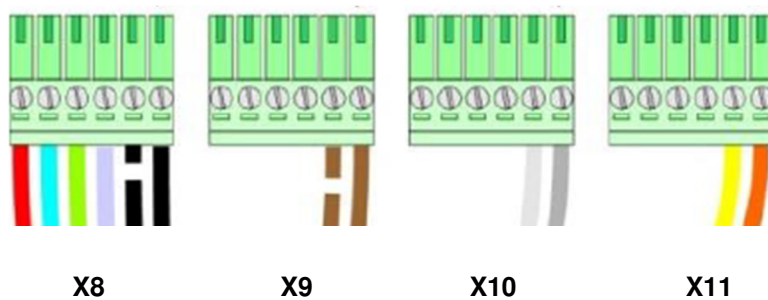


Figure 15: Connector pins to connect Corona II to XLC4

#### Distribution of the currents

- **X8-X11** must be in proportion to each other in order to achieve a good **D50** spectrum. Channel 2 warm white LED (**X9**) is taken as a reference to control the remaining channels.

- In cases where UV is not required, the UV channel can either be disconnected from the XLC4 or can be switched off in the XLC4 Commander.
- The currents can be adjusted by using the supplied software (XLC4 Commander), as shown in chapter [4.4](#).

**NOTE:** In the first application, the factory settings are installed on the XLC4-Controller. To avoid damage on the Corona II illumination, please follow the introductions in chapter [4.4](#) before switching on the illumination.

#### 4.3.2 Connect the truePIXA

On the back side of the camera you will find the following connections:

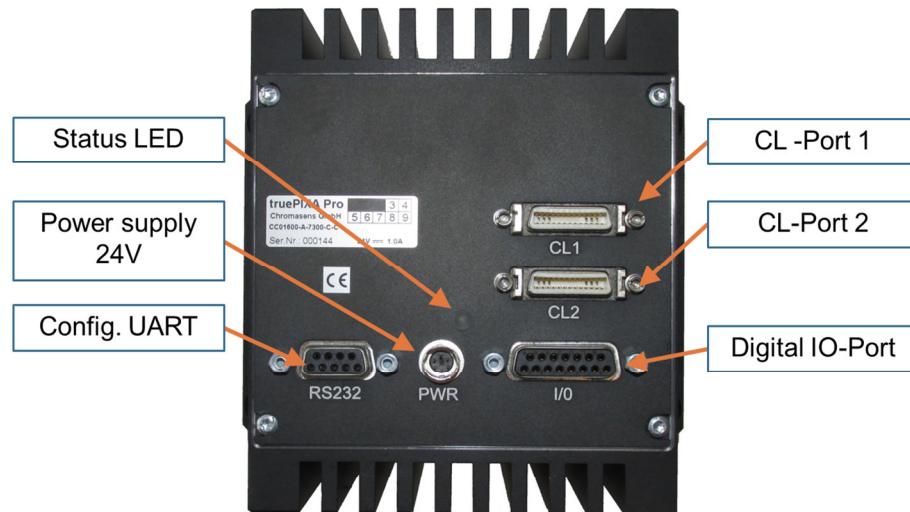


Figure 16: Various ports of the truePIXA

- Camera Link ports (CL 1 and CL 2) for image signaling and for communication between the truePIXA camera and the PC (frame grabber).
- Digital port (I/O interface D-Sub 15 female) or the incremental encoder signal, light barriers and other freely-programmable inputs and outputs.
- Serial port (serial RS 232 D-Sub 9 female, Config UART) for additional communication (e.g. configuration signals) between the truePIXA camera and the PC.
- Power supply (Hirose HR10A-7R-6P, 24V, male)
- Status LED for indicating the truePIXA camera status.

#### 4.4 Setting up the XLC4 controller

After the interfaces, the power supplies and the XLC4 controller are connected please follow the procedure shown here. All described programs and files can be found on the partner area of the [Chromasens homepage](#).

- Download XLC4Commander\_Vx\_x.exe locally on your computer.

**NOTE: Please don't control the current of a Corona II D50 illumination by a value in the "current" line and don't activate the camera on the on/off function. Because of the proportional channel values, the current must be controlled by entering a command line. This function is available in XLC4 Commander Version V5.1.**

- Start the XLC4 Commander

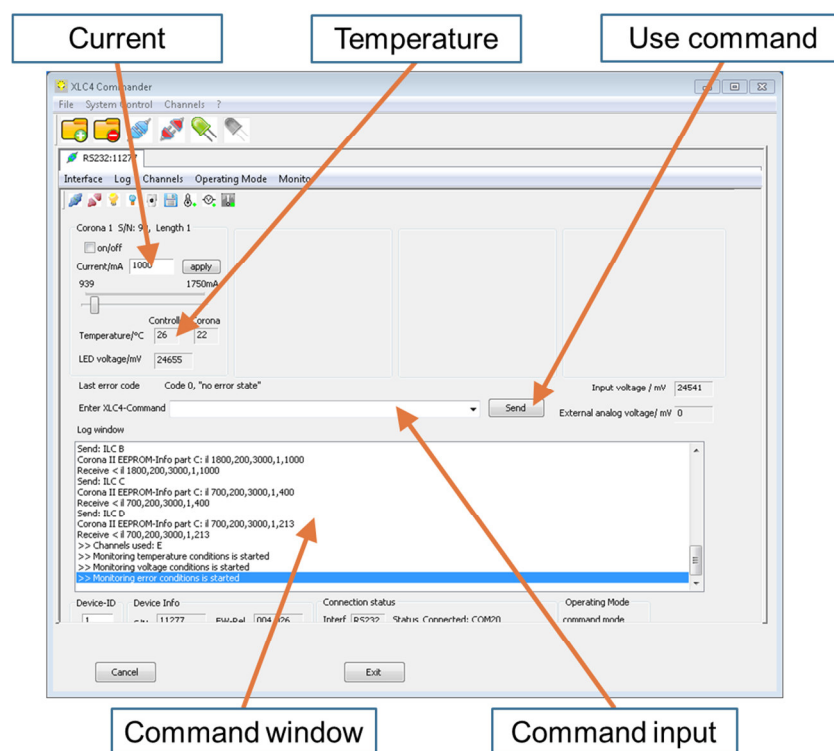
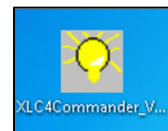


Figure 17: Functional overview XLC4 Commander

#### 4.4.1 Connecting the XLC4-controller

- 1) Select the correct COM-Port to connect the XLC4-controller with the pc.
- 2) The assignment of COM-Ports can be found in the Windows Device Manager.

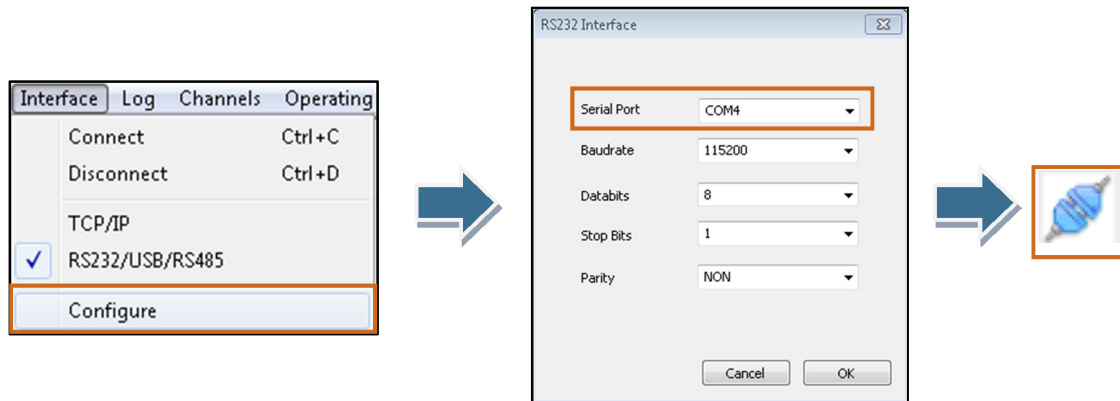


Figure 18: Setting the right COM-Port

#### 4.4.2 Switch on the fan

Switch on the fan for a stable light source and a precise color measurement.

- 1) Before you do that make sure that the wires for the fan cooling are connected to the XLC4 controller (**X5**).
- 2) Type in the “Enter XLC4-Command” line “FC 57,57 W”, click the “Send”-Button

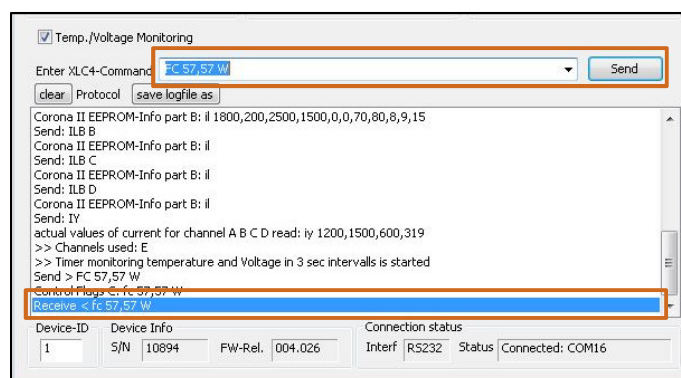


Figure 19: Setting the cooling temperature

- 3) Now the fan should turn on at the temperature 57°C and the settings are saved for the next session.
- 4) Our recommended temperature for good stability of light source is between 55 and 57° C. The commands could be – FC 55, 55 W or FC 56, 56 W or FC 57, 57 W.

- 5) In case of liquid cooling systems, the temperature is controlled externally and not from the XLC4.
- 6) You can use the command

#### 4.4.3 Setting up the current level

Once the XLC4 is connected, it is important to set the current levels.

- 1) Giving the command “IY” this will help to know whether the controller is working according to the proportions required for different LEDs in D50 light.

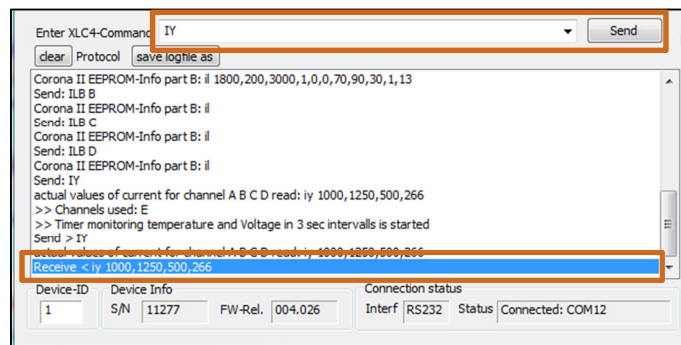


Figure 20: Checking the current levels

- 2) With the “IY 1500 W” command the current on the 4 channels is evident.

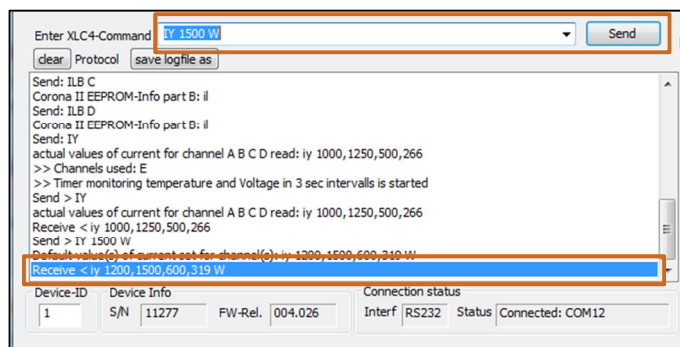


Figure 21: Writing the new current level on the camera

- 3) When warm white is 100% then the others are – Cold white (80%), UV (40%), blue-green (21.3%). This proportion must be maintained.



- 4) Therefore the other channels also change the current in proportion to this channel as explained earlier in this chapter.
- 5) To switch on the illumination type “LC 1” in the command line.
- 6) To switch off the illumination type “LC 0” in the command line.
- 7) The illumination channels can be switch on separately by typing “LC A 1”, “LC B 1”, “LC C 1” or “LC D 1” in the command line.

**NOTE: The current must be checked every time before activate the illumination. Please refer to XLC4 Commander manual to know more on other functions of the Commander and controller.**

## 5 Setting up the truePIXA

### 5.1 Setting up the illumination angle based on the signal

- 1) Display the signal along the sensor line and point the truePIXA camera on the white reference.
- 2) Rotate the Corona II line light to find the maximum of the RGB sub-images.

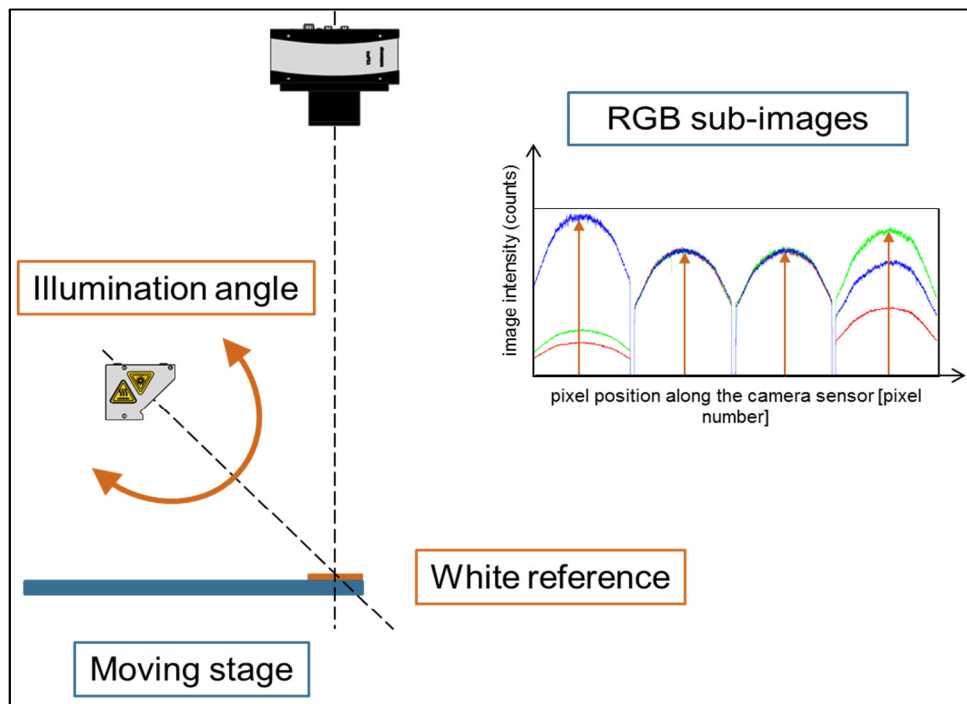


Figure 22: Setting the correct illumination angle

- Only use a flat and spatially homogeneous target for the adjustment of the Corona II line light and the calibration of the truePIXA.
- The white reference must be at the same height level as the sample with respect to the camera working distance.

## 5.2 Gain and target reference value settings

### Points to remember

- The gain settings for truePIXA are different as compared to a normal allPIXA, allPIXA pro or 3DPIXA. The difference arises due to the fact that the truePIXA comprises of different color glass filters in front of the RGB sensor.
- Generally the gain-balancing function is carried out using the Chromasens CST tool. It is important that the gain settings are done properly. For general information about CST and all its functions, please refer to the CST Manual. Chromantis cannot be used to do the basic camera settings.
- The Getting Started – truePIXA only describes how the gain adjustment is done for truePIXA. If you want to set any other parameters such as encoder, image size, physical setup, camera I/O functions etc. please refer to the CST manual.

### 5.2.1 Preparations

- 1) To view the image plot and the signal strengths, you must use a visualizing tool (either the software of the frame grabber you are using or your own developed application tools)
- 2) You are using the right configuration of the CamerLink cables, if the first RGB sub-image has a high blue level and low red and green level (see [Figure 24](#)).
- 3) The camera must be pointed on the white reference to show the following signal values.

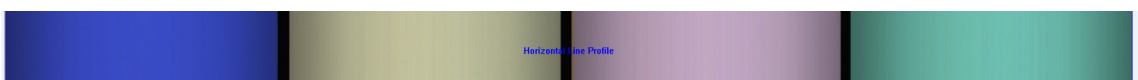


Figure 23: truePIXA raw image consisting of four RGB sub-images

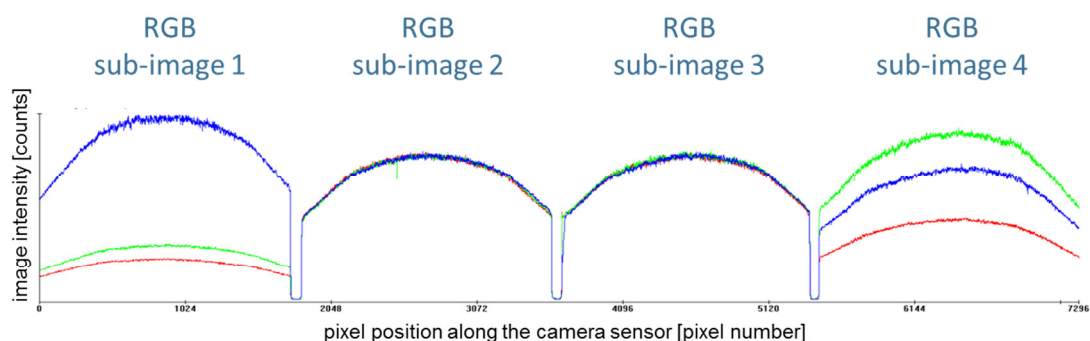
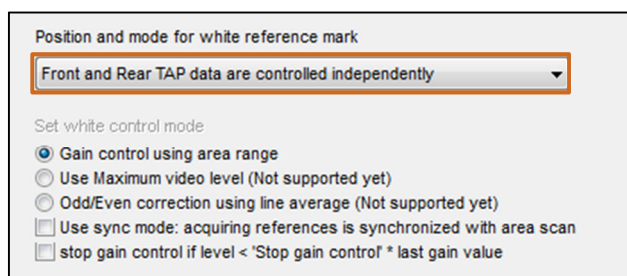


Figure 24: Image intensities of the raw RGB image. The plot contains intensity profiles of the white reference for each of the four RGB sub-images.



- 4) Open the Camera Setup Tool (CST).



- 5) If the connection cannot be established on Port 0, please change the order of the Camera Link cables. It's important to connect Port 0 in CST to keep the right order of the RGB sub-images in the live signal.
- 6) It is important to know that the front and rear tab in the case of truePIXA are controlled independently as shown in the [Figure 25](#).



*Figure 25: Setting the front and rear TAP*

- 7) Each setting must be sent to the camera
- Option 1: Transfer the settings into the volatile memory by using .
  - Option 2: Burn the settings into the camera memory so that the settings will remain, even after powering the camera off by using .

## 5.2.2 White reference mark

CST has the functionality to illustrate a marker in the image for the white reference zone as shown in

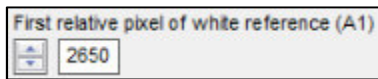
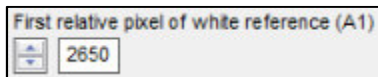


Figure 27.



- 1) First you have to check the positioning of the white reference mark. Therefore you have to display the white reference border in the image.

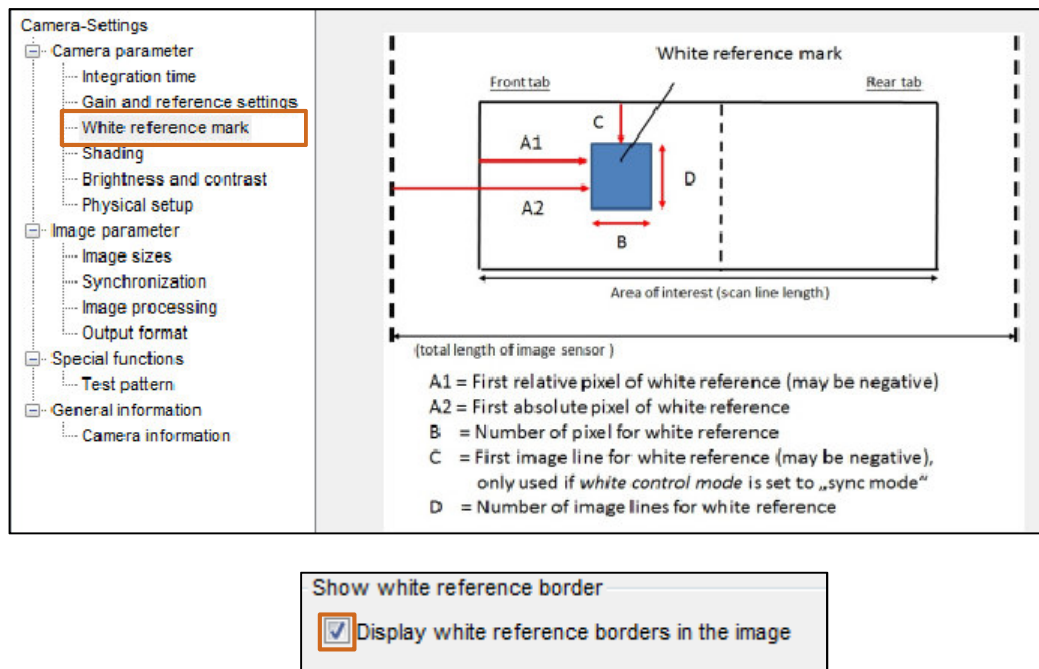



Figure 26: Display the "white reference mark" in CST

- 2) Transfer the setting to the camera by using .
- 3) You can check the positioning of the white reference boarder in RGB sub-image 2 and RGB sub-image 3.

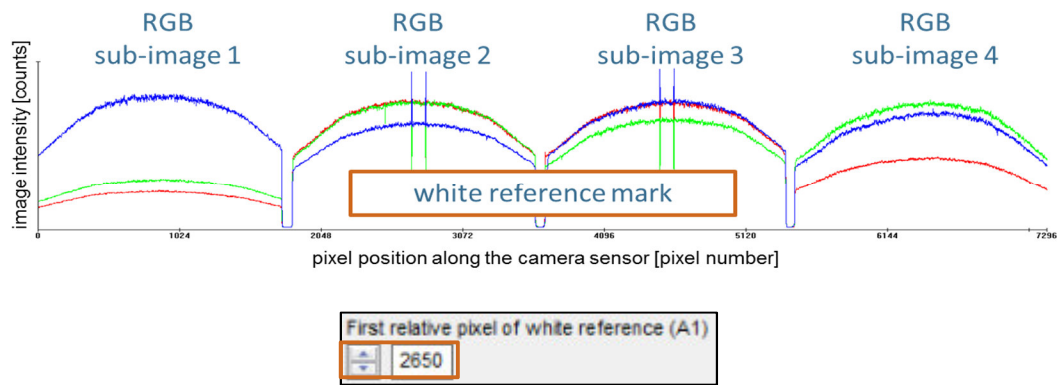



Figure 27: White reference marks after setting "Display white reference borders in the image" as shown above.

- 4) Increase or decrease the value of the "first relative pixel of the white reference (A1)" till the boarder marks are in the center of the RGB sub-images, where corresponding signals are maximal.
- 5) Once the setting is completed, illustration of the white reference border marks has to be deactivated and the setting will be send to the camera by using .

## 5.2.3 Gain values

### 5.2.3.1 Basic setup to start the gain settings

- 1) It is important that the analog coarse gain is set to 0 dB when you start to adjustment of the gain settings. You can set the green marked value to use the “set all equal button”.

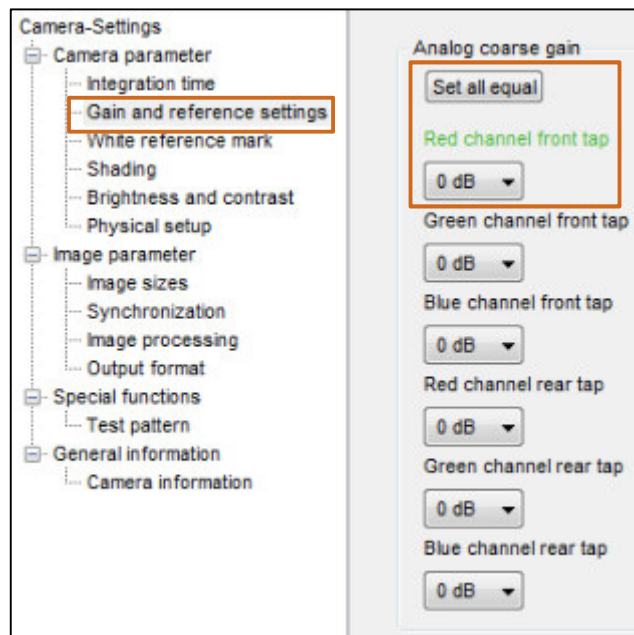


Figure 28: Analog coarse gain settings in CST

- 2) The white control must be enabled while doing the gain/white reference settings.

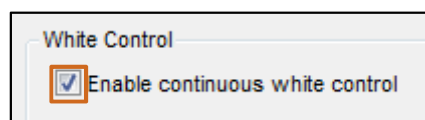


Figure 29: "Enable the continuous white control" in CST

- 3) The “target white reference values” set on 800 to start with. You can set the green marked value only and use the “set all equal” button.

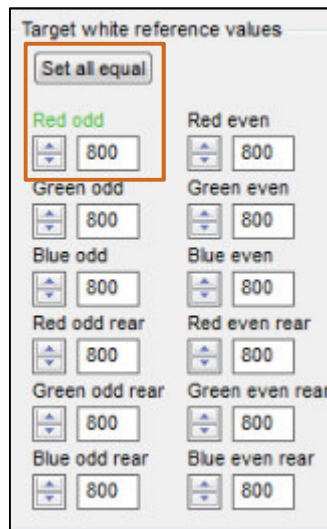



Figure 30: Setting the "target white reference values" in CST classified in front- and rear tab and the RGB part of these tabs.

- 4) All settings must be send to the camera by using .

### 5.2.3.2 Setting the target white reference values

Target white reference values are used to automatically adjust the gain settings in the camera setup phase. Because there exist only two white reference marks corresponding to only two analog amplifier groups (front- and rear tab), but 4 RGB sub-images, adjustment has to be performed manually.

The aim is to set the target reference white values such that the maximum signal in each RGB sub-image and every channel does not exceed 200 counts.

The target signal value of the white reference depends on the remission. If you are using the Chromasens white reference there is a remission of  $R=0.85$  (85% of incoming light is reflected). The maximum of a 8-bit greyscale is 255. Taking into account an offset of the camera and the remission of the white reference, the maximum of the RGB sub-images must set to  $y_{new} = 200$ .




- 1) The first calibration step is to set the right “target white reference values” for RGB sub-image 1.
- 2) Check the maximum value ( $y_{old}$ ) of RGB sub-image 1
- 3) Read the old “target white reference values” in CST (see [Figure 30](#)) and calculate the new input value by using the [Equation 1](#) below.

$$x_{new} = \frac{y_{new} * x_{old}}{y_{old}}$$

*Equation 1: Calculate the new “Target white reference value”*

$x_{new}$	Input “Target white reference value”
$x_{old}$	Current “Target white reference value”
$y_{new}$	Target signal value in the live picture
$y_{old}$	Current signal value in the live picture

- 4) Change the “target white reference values” and update the display by using .
- 5) Please pay attention to the “current camera gain values” while changing the “target white reference values”. It is important that they never reach the value 0 or 800.



Current camera gain values	
<input type="button" value="Set all equal"/>	
Red odd	Red even
<input type="text" value="289"/>	<input type="text" value="288"/>
Green odd	Green even
<input type="text" value="322"/>	<input type="text" value="315"/>
Blue odd	Blue even
<input type="text" value="252"/>	<input type="text" value="253"/>
Red odd rear	Red even rear
<input type="text" value="117"/>	<input type="text" value="126"/>
Green odd rear	Green even rear
<input type="text" value="101"/>	<input type="text" value="101"/>
Blue odd rear	Blue even rear
<input type="text" value="174"/>	<input type="text" value="169"/>

*Figure 31: Description of the “Current camera gain values” in CST*

- 6) The aim is to bring all the maximum signal values to the same level of  $y_{new} = 200$ , therefor the values of the other RGB sub-images also must be adjust.

- 7) Change the “target white reference values” till all maximum have reached the same level.
- 8) The gain setting circuit is illustrated in [Figure 32](#). The circuit starts with the RGB sub-image 1, after passing the circuit it will be repeated for the next RGB sub-image.

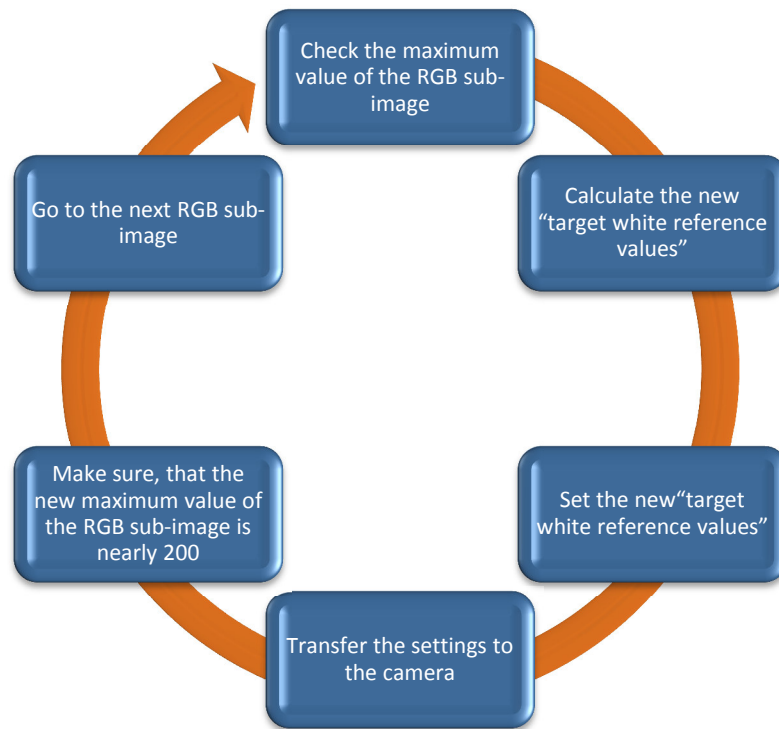


Figure 32: Gain setting circuit to set the right “target reference values” for RGB sub-image 1 to RGB sub-image 4

- 9) To set the right “target white reference values” the gain setting circuit must be run four times.
- 10) After the adjustment, the signal should look like [Figure 33](#). The RGB sub-images should have the same maximum value  $y_{new} = 200$ .

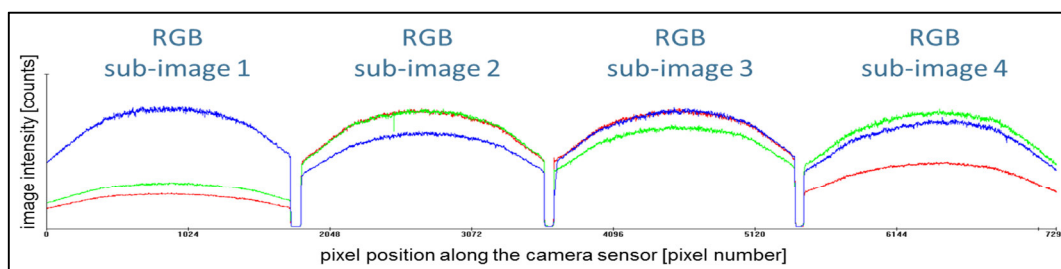




Figure 33: RGB sub-images after setting the “target white reference values”


### 5.2.3.3 Setting the analog coarse gain

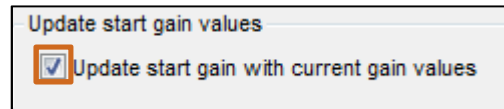
- 1) The value of the analog coarse gain depends on the intensity of the illumination.
- 2) If the intensity is too low you can increase the illumination current in the XLC4 Commander by the command "IY 1500 W" or increase the integration time of the CCD line sensor in CST.
- 3) The aim is to have "current camera gain values" between 20 and 200 for a good signal to noise ratio (see [Figure 31](#)).
- 4) If the "current camera gain value" is too high (see [Figure 31](#)) and there is no possibility to change the illumination settings you have to increase the "analog coarse gain value".
- 5)



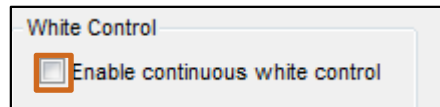
Figure 34: Analog coarse gain settings in CST


- 6) Every change must be sent  to the camera and the values must be updated .

- 7) After you finished the gain settings you have save the gain values on the camera. But first you have to update the start gain of the camera and send this to the camera by .



- 8) Switch off the enable white control button.



- 9) Burn the settings in the camera permanently by using .

**NOTE: For further information CST settings, please refer to the CST Manual.**

## 6 Calibration

The next calibration steps can be made in the Chromasens Chromantis software, which can be found on the partner area of the [Chromasens homepage](#). They are very important for an accurate color measurement. Please use the Chromasens Chromantis software manual for a detailed description of all calibration steps.

### 6.1 Dark offset correction

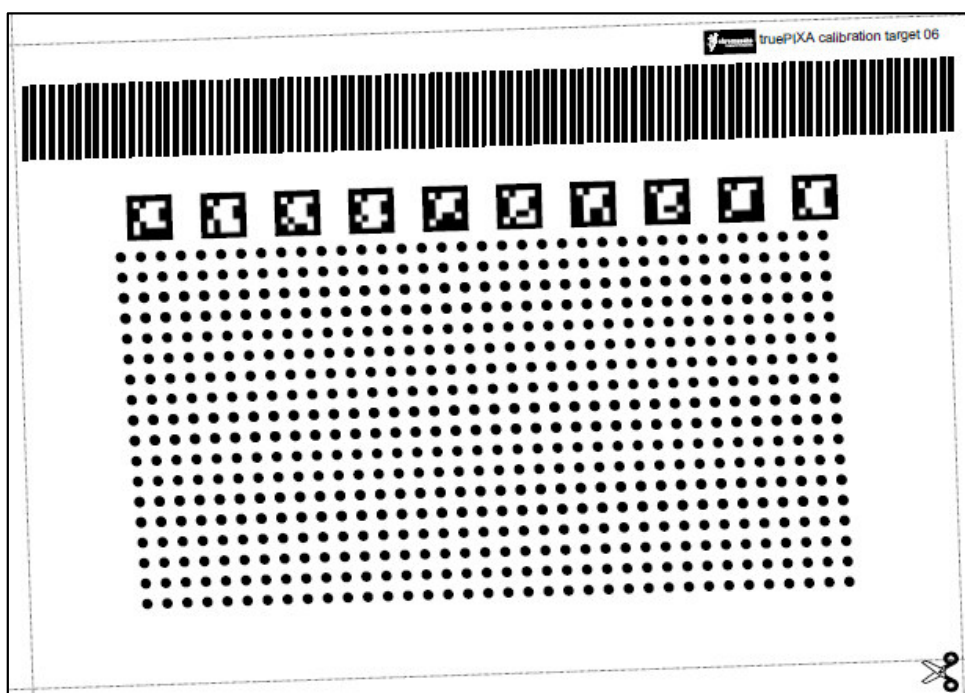
Color measurement is sensitive to the changes in signal strengths. Especially, color measurement is extremely sensitive in the dark region of the spectrum (low signal strengths). The black noise is stochastic in nature. If the black correction is done in CST, the negative values are moved to positive. This leads to a shift in the black reference above the value of 0. For color measurement, this condition is not good. It is important that the black reference is really 0 in order to get the required dynamic range especially for dark colors. This holds true also for the shading correction.

**NOTE: Chromantis corrects shading and black in a floating fashion. Hence it is more accurate than using just CST. If you are not using Chromantis for this function, you could very well use the API to carry out black and shading corrections.**

### 6.2 Geometry Calibration

Geometry calibration is the next step after setting the dark offset correction. The basic purpose of this calibration, as the name suggests is to bring the geometric coordinates of the 4 different images in case of truePIXA 12 channels, 2 different images in case of truePIXA 6 channels together. For this calibration, Chromasens has developed a special geometric chart which looks like in [Figure 35](#).

**NOTE: This truePIXA geometry chart can be downloaded in the partner area of the Chromasens homepage.**



*Figure 35: Geometric calibration chart from Chromasens*

The charts are printed to different scales in-order to fit with different models and scanning widths of the truePIXA. The content of each chart is the same. The scaling helps to adapt the chart design to all widths. The charts are available today in three different widths namely: 90 mm, 360 mm and 180 mm. Based on the scanning width of your truePIXA model, these charts can be scaled to fit to your requirement.

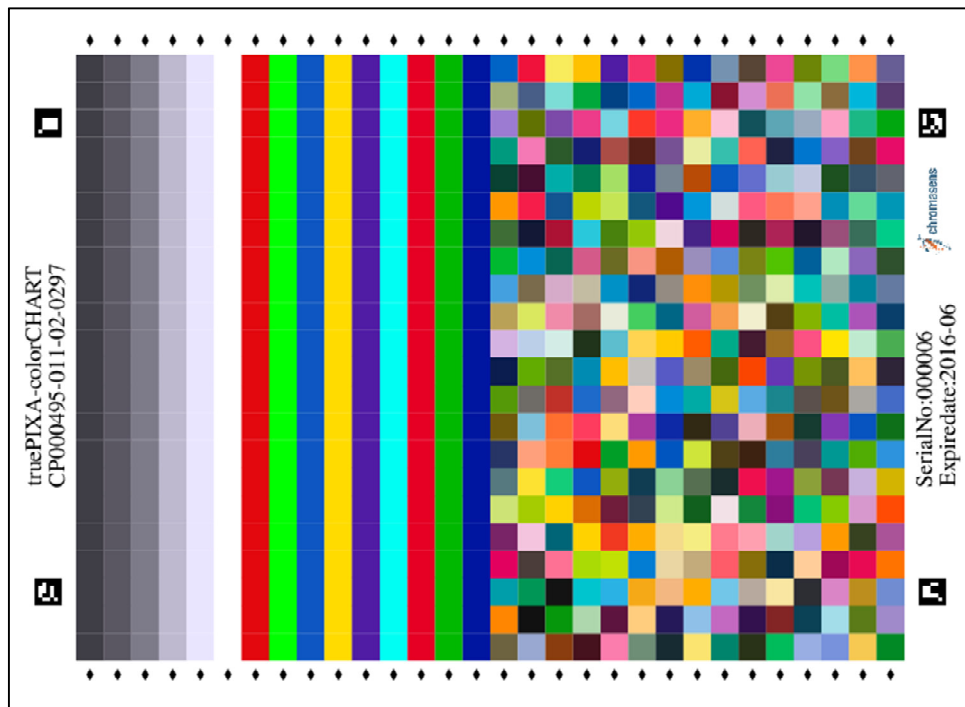
Base number	Chart number	Chart width (mm)
CP000496-	001-	0360
CP000496-	001-	0090
CP000496-	001-	0180
CP000496-	001-	0270

*Table 4: Chart coding of the Chromasens geometry calibration chart*

**NOTE: Chromantis Guide chapter 5 consists of more details as to how to carry out the calibration using Chromantis.**

### 6.3 Color Calibration

The last step in the calibration process is the color calibration. The correct camera working point and good geometric calibration are the pre-requisites to color calibration. For color calibration, you need color charts which are designed and developed at Chromasens GmbH.



*Figure 36: Chromasens color calibration chart*

**NOTE:** These charts are not included in the camera price. You need to order them separately!

The truePIXA color calibration chart is available in different types and sizes. This is a list of available charts:

Base number	Chart number	Revision	Chart width (mm)	Patch size (mm)	Rows x columns
CP000495-	011-	02-	0297	12.0x12.0	30x22
CP000495-	011-	02-	0210	9.0x9.0	30x22
CP000495-	011-	02-	0170	6,3x6,3	30x22
CP000495-	013-	01-	0085	7.2x7.2	28x10
CP000495-	013-	02-	0085	7.2x7.2	30x10
CP000495-	014-	01-	0095	7.2x7.2	28x12
CP000495-	015-	01-	0075	4.0x4.0	26x16

*Table 5: Chart coding of the Chromasens color calibration chart*

**NOTE:** The chart with chart width 297 mm, shown in [Figure 36](#), can be used for any width above this width. Please make sure that you have the right chart.



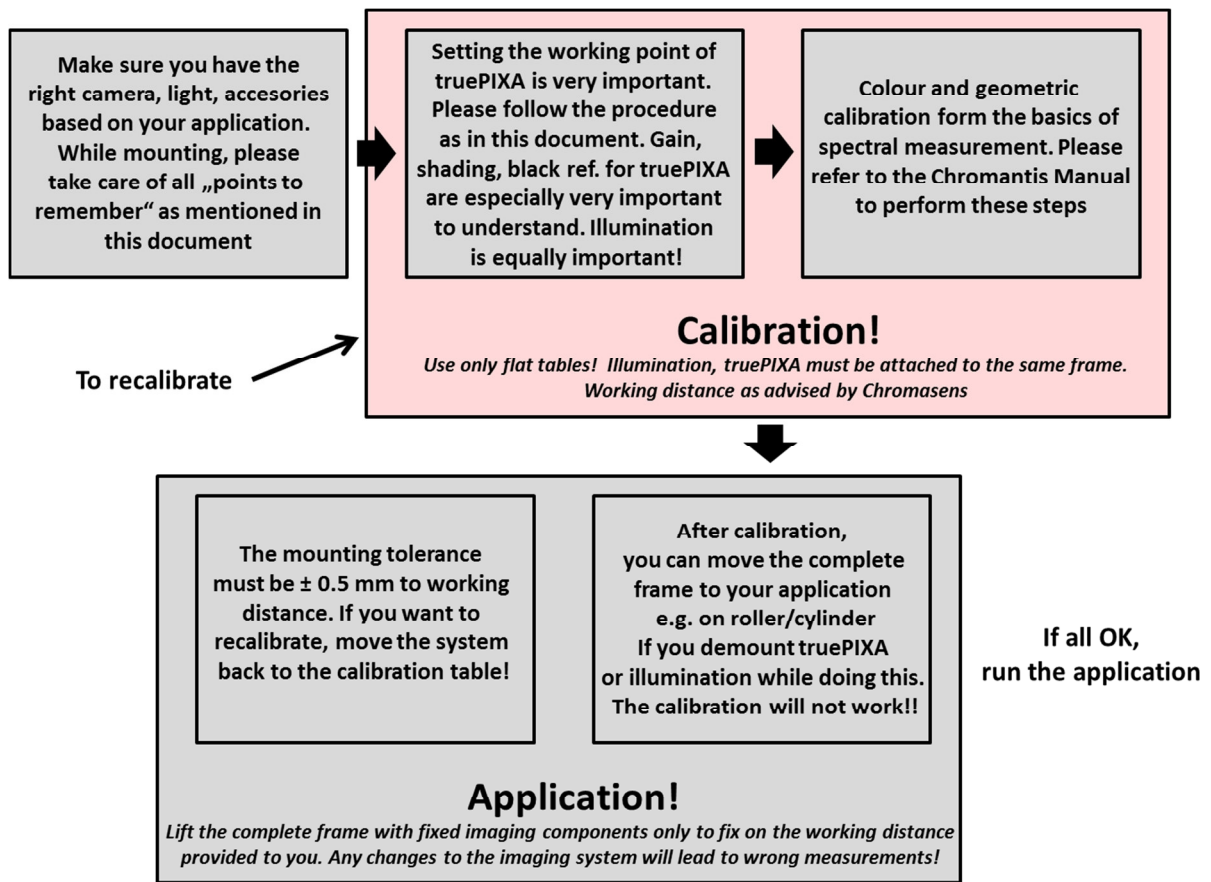


Figure 37: Workflow for the calibration of a non-flat surface

[Figure 37](#) shows a workflow depicting how calibration is actually the most important step to work with the truePIXA and how it differs with the application on non-flat surfaces. If the calibration table and application table are the same, then there is no need to demount the frame.

Please remember that the system should not be dismantled on the application if you want to change some component or other parts related to the imaging system. In such a case, the complete frame must be demounted from the application, assembled with the replaced parts, recalibrated and then mounted back on the application. Any other way will not work!

**NOTE:** Please refer to Chromantis Manual chapter 5 for details on how to carry our color calibration.

Chromasens GmbH

Max-Stromeyer-Straße 116

78467 Konstanz

Germany

Phone: +49 7531 876-0

Fax: +49 7531 876-303

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

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