

user manual

pc_o.pixelfly usb



pco.

PCO asks you to read this manual carefully before using the pco.pixelfly usb camera system and follow the instructions.

Contact us for further questions or comments.



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The cover photo shows a typical pco.pixelfly usb camera system. The lens is sold separately.

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1. INTRODUCTION



Advantages of the pco.pixelfly usb

Features

This versatile high performance 14 bit CCD camera system has an extraordinary quantum efficiency of up to 62%. At the core of the camera a FPGA processor provides sophisticated control and accurate timing of the CCD and associated electronics. In addition, a proprietary offset control algorithm has been developed providing very high offset stability, regardless of ambient temperature or signal changes, ensuring accurate and repeatable quantitative data over long periods of time.

The camera's main features are:

- **resolution:** 1392 x 1040 pixel
- **superior quantum efficiency** up to 62%
- **4000:1** dynamic range
- **superior low noise** of $6e^-$ rms @ 12MHz
- **no glow effect** at long exposure times
- **excellent DSNU** at long exposure times
- **outstanding offset stability** and control (<1count)
- **hot pixel correction** integrated
- **USB2.0** interface

1.1 INTENDED USE

This camera system is designed for use by technicians, engineers and scientists. It is a scientific measuring instrument, which provides images. The camera may only be used according to the instructions of this manual. Provisions, limitations and operating conditions stated in this manual must be respected. Unauthorized modifications or alterations of this device are forbidden for safety reasons.

Areas of Application (Examples)

- | | |
|------------------------------------|----------------------------|
| • scientific imaging | • material testing |
| • low light level imaging | • scintillation recording |
| • combustion imaging | • bioluminescence |
| • high resolution microscopy | • chemoluminescence |
| • luminescence spectroscopy | • flow visualization |
| • quality control | • machine vision |
| • spectroscopy | • imaging of bio markers |
| • fuel injection | • Red and NIR fluorescence |
| • particle image velocimetry (PIV) | • industrial applications |

2. SAFETY INSTRUCTIONS

Please read the safety instructions completely and follow them always.



DANGER

DAMAGED POWER CABLE OR POWER PLUG

Danger to life due to electric shock.

- Each time the camera is used, check the power cable for damage.



WARNING

ELECTRIC SHOCK WARNING DUE TO VOLTAGE PARTS INSIDE

Risk of injury due to electric shock.

- Do not open the camera.



CAUTION

MOISTURE

Risk of injury due to electric shock if moisture enters the camera.

- To avoid the risk of water condensation, protect the camera against extreme changes of ambient temperature.



CAUTION

TRIPPING HAZARD

Risk of injury from tripping over loose cables.

- Never position the cable in a way that it could become a tripping hazard.

NOTICE

HUMIDITY, DUSTY OR RADIATION

Humidity, dust or X-rays could damage the camera.

- Never operate the camera in humid or dusty environments or in places with high level of x-ray radiation.

NOTICE

SHOCK & VIBRATION

To avoid damaging the camera it must be firmly mounted and protected against strong shocks or vibrations.

- Use the camera's mounting threads to secure it.

NOTICE

LENS MOUNTING

Do not force the lens onto the camera.

- To protect the lens connector thread from damage, screw in the lens gently to avoid thread damage.

NOTICE

LIQUIDS DAMAGE CAMERA

If liquids have penetrated the device.

- Switch the camera off immediately, detach it from power and contact PCO's customer support.

NOTICE

DAMAGED CAMERA HOUSING

If the camera has been dropped or the body is damaged.

- Switch the camera off immediately, detach it from power and contact PCO's customer support.

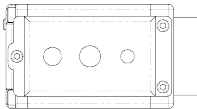
NOTICE

IF CAMERA IS NOT WORKING PROPERLY

In case all actions following this manual to get the camera working properly were unsuccessful the device is still not operating properly.

- Switch the camera off immediately, detach it from power and contact PCO's customer support.

3. SYSTEM COMPONENTS



The camera system includes the following parts.

Camera

C-mount optical connection:

The distance between the front edge of the c-mount and the sensor is 17.52 mm. The standard C-mount lenses and adapters.

DC Power Jack (connects to power supply)

USB 2.0 Connector (connects to PC)

RJ11 (connects to I/O device)

LED indicates camera status (see A1.6)

Serial Number Tag

Mounting Thread

3/8"-16 UNC 1/4"- 20 UNC

Trigger Interface (I/O Device)

Proprietary RJ11-BNC connector for Trigger / Busy / Exposure signals

Power Supply

AC to 12V/DC power supply

USB Cable

USB-A / USB-B cable (5 m)

Digital Camera Tools (USB flash drive content)

- Camware: software for camera control & image acquisition
- Camera driver & tools
- Software development kit (SDK) & demo programs in C and C++

4. INSTALLATION

You will find all necessary files on the accompanying USB flash drive. You may also download the latest versions of our software, camera driver and third party software drivers from our Website (www.pco.de).

Minimum system requirements:

- Clock speed > 1.6 GHz
- RAM > 512 MB
- Windows 7
- 1280 x 1024 pixel resolution display
- USB 2.0

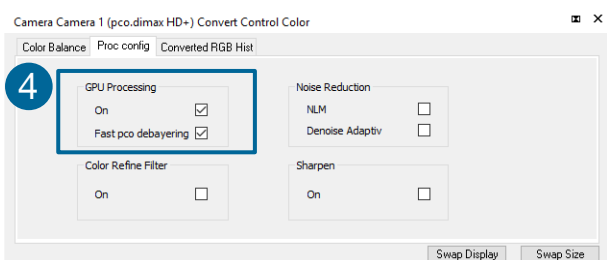
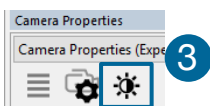
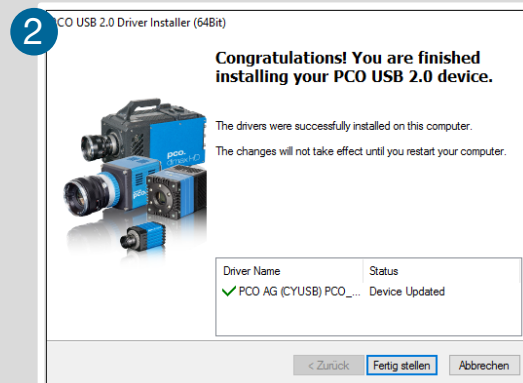
4.1 DRIVER

Start the USB 2.0 driver installation from your usb flash drive. **Don't connect the camera** to your computer before driver is completely installed.

Run the provided installation file and follow the instructions of the installation wizard. **1**

After finishing **2** the driver installation wizard **connect** your pco.pixelfly camera to its power supply and via enclosed USB 2.0 cable to your computer.

The first time the camera is connected via USB to computer, Windows will notify the user that a new device has been detected.



NVIDIA Cuda Driver:

Please update your NVIDIA driver for Camware 4. In case of an old driver version **GPU Processing** is not working. Therefore image processing is slow.

Please check if **GPU Processing** is activated by having a look into the **Proc config settings** **4** in the **Convert Control window** **3** (see Convert Control chapter 6.3.6).

If **GPU Processing** is disabled and shown grayed, please update your NVIDIA driver. Your NVIDIA driver version must be at least **333.11** or higher.

4.2 CAMWARE

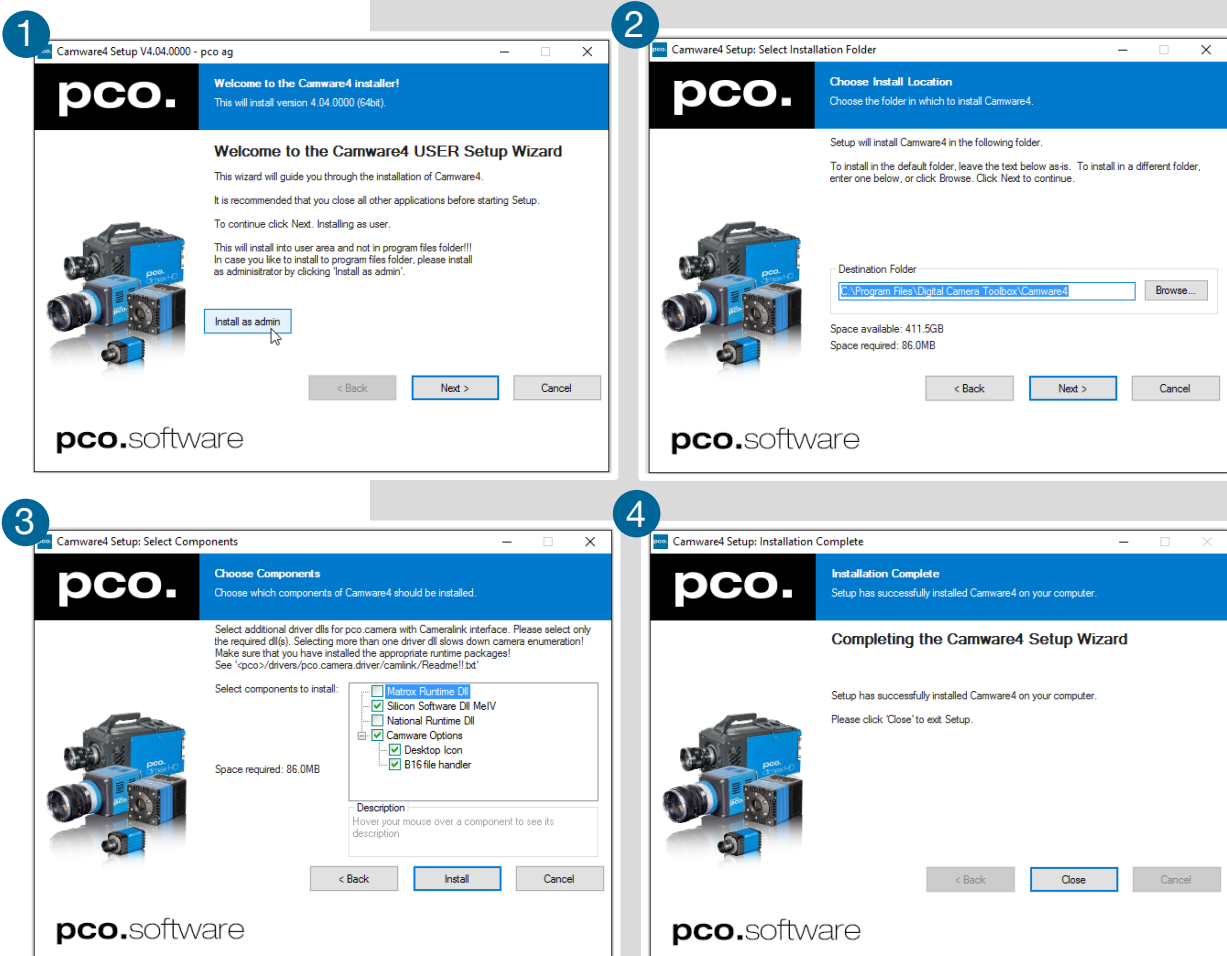
The Camware Windows application software enables to control every camera parameter or setting. Images can be displayed on a monitor and may be downloaded and stored. The USB flash drive contains the installation files for the software for latest Windows operating systems in 32 & 64 bit.

After a successful installation, you will find the program file **Digital Camera Toolbox** in your program directory and a **Camware 32 / 64 button** on your desktop. Other helpful tools are also installed in the same directory.

To uninstall the Camware program, please use the Software feature under Windows' System Control.

Please follow the installation wizard

- 1 Install Camware as **Admin** to install to program folder, otherwise it will be installed only to user folder.
- 2 Then choose install directory.
- 3 Choose components: select additional drivers.
- 4 After the next two screens installation is complete.



5. QUICK START

In order to get familiar with your new camera and software it might be helpful, first to aim the camera at an object easy to focus and visible at normal light conditions.

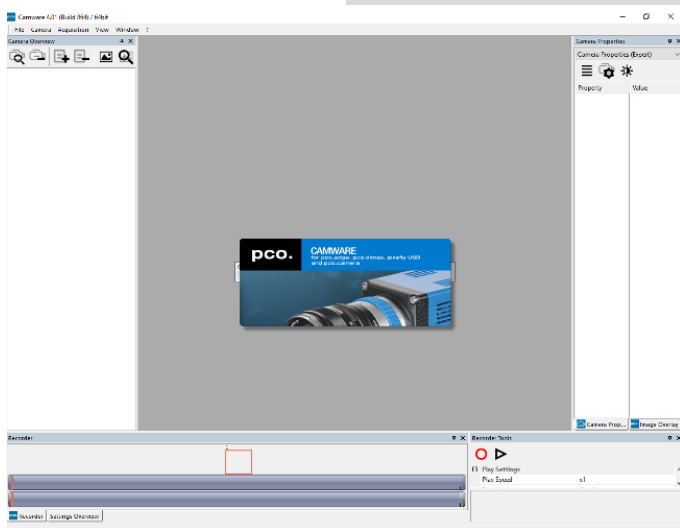
5.1 PREPARATION

- **Computer** is turned on
- **Installation** is finished (see chapter 4)
- **An appropriate lens** is attached (remove cap) or the camera is attached properly to the microscope, spectrograph or other scientific device
- **Camera** is connected to the PC
- **Camera** is connected to the power supply and ready (LED green)

5.2 START



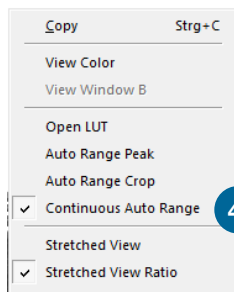
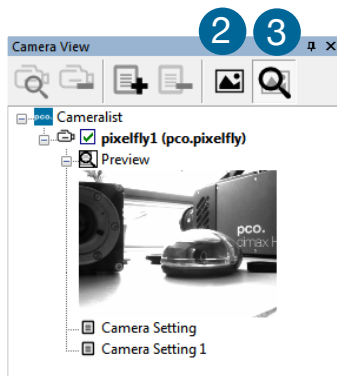
Start **Camware** and the **graphical user interface** will start up:



NOTE

Always install latest Camware version to be able to use full functionality of your pco camera (www.pco.de/support).

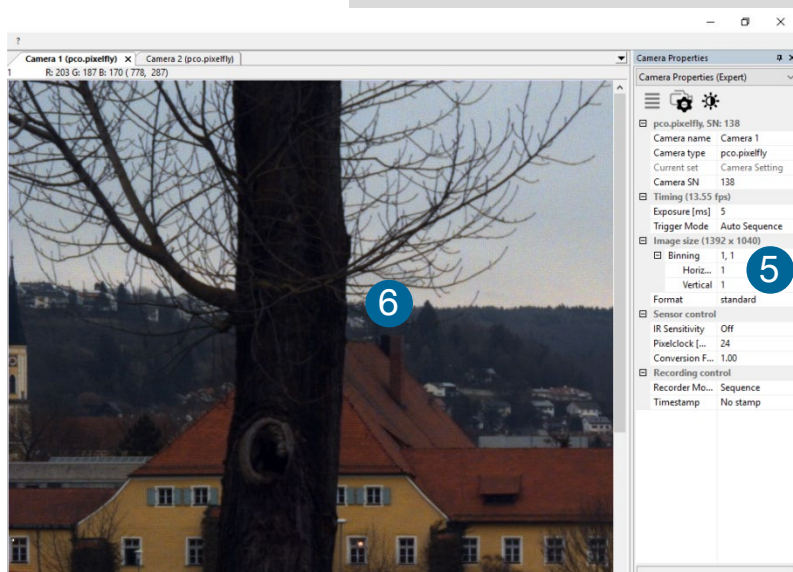
5.3 FIRST IMAGE



Please follow the instructions:



- **Camware** must be started **1**
- A view window **2** is shown automatically / or open a new one
- Start **live preview** **3**
- Right-click in the view window and apply **Continuous Auto Range** **4**
- You may have to adjust **exposure time** **5**, **aperture** and **focus**
- Now you should clearly **6** see the **object** in the window



If you need to change **exposure** time (e.g. the image is still either too dark or too bright), please go to chapter **6.2**

For recording and saving images, please see chapter **6.3.4** and chapter **6.9** for detailed information.

NOTE

Live preview: Useful for fast and easy camera adjustment and focusing.

6. CAMWARE 4 SOFTWARE



PCO's Camware is outperforming software for camera control, image acquisition and archiving of images in various file formats. This chapter provides a detailed description of all Camware functions.

Camware works with any kind of PCO camera. Visit **PCO website** for the latest version of this software.

6.1 CHAPTER OVERVIEW

Chapter 6.2: lists all connected cameras

6.2 Camera Overview/List	Preview / Connected cameras / Recording profiles / Master sets
---------------------------------	--

Chapter 6.3 *Camera Properties*: main dialog for all camera settings:

6.3.1 Timing	Timing settings / Trigger modes
6.3.2 Image Size	Sensor format / Binning
6.3.3 Sensor Control	Double shutter / IR sensitivity / Pixelclock / Conversion factor
6.3.4 Recording Control	Recorder Mode / Timestamp
6.3.5 Status	Electronics temperature
6.3.6 Convert Control	Contrast / Saturation / Gamma...

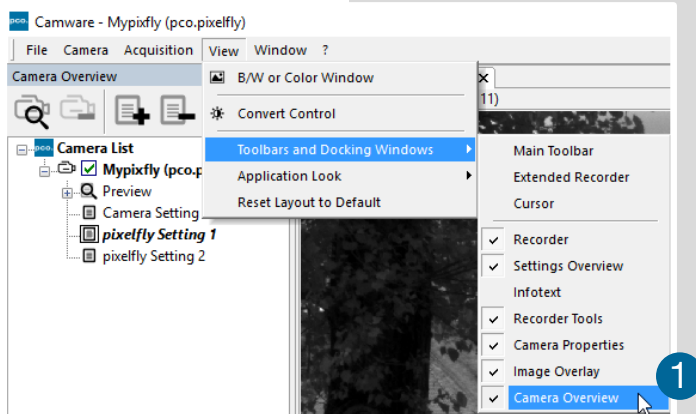
Chapter 6.4/ 6.5 /6.6 /6.7 / 6.8 describe the recording functions

6.4 Image Overlay	Overlay for recorded images
6.5 Recorder Tools	Record / Play / Settings
6.6 View Window	View window functions
6.7 Recorder (Images)	Preview of recorded images
6.8 Settings Overview	Overview of all parameter settings / Auto Save

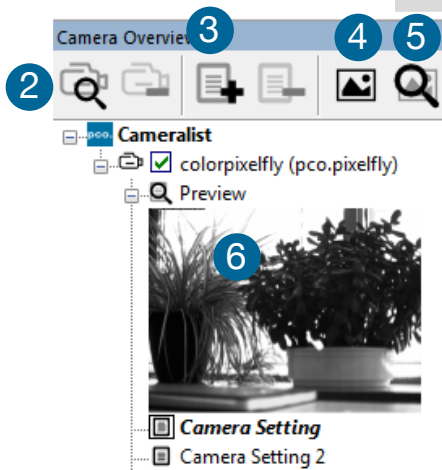
Chapter 6.9 describes all tabs, the right-click menu and additional features.

6.9.1 Demo Mode	No camera connected
6.9.2 File	Open / Save / Print files / Options / Avi Codec Dialog / Direct record to file / Lookup table
6.9.3 Camera	Camera control / Close / Rescan
6.9.4 Acquisition	Live preview / Acquire sequence / Rec. memory settings
6.9.5 View	New window / Convert control / Multi window / Toolbar / Application look
6.9.6 Window	New / Close / Split window
6.9.7 Help	Logfiles / Support file / About
6.9.8 View window menu	Right-click: Zoom / Flip / Mirror / Rotate...
6.9.8 Additional features	White Balance / Contrast / Short cut list

6.2 CAMERA OVERVIEW / LIST



If closed, the **Camera Overview** window can be opened by selecting the **View** tab and **Toolbars and Docking Windows** → **Camera Overview** ①.

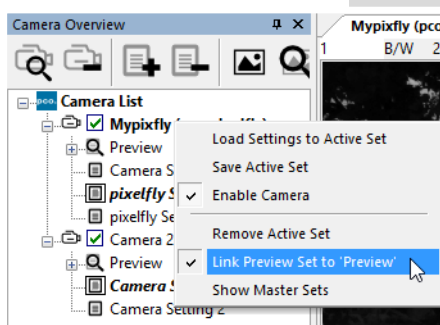


The **Camera Overview** window allows to manage more than one connected PCO cameras. It displays a list of all connected cameras. Camware is able to **scan** ② for connected cameras or close a connected camera. It allows to define different **Settings** for each camera (max. 30 sets per camera → **add new set** ③). **New view windows** ④ can be opened and the **Live Preview** ⑤ function started. When opened up, the **Preview** shows a **small preview window** ⑥ (always monochrome) integrated in the camera list.

Live preview facilitates the aperture and focus adjustment, allowing a first look at your object. During live preview no images are saved into the computer's RAM.

During **Live preview Trigger** and **Acquire mode** are set to **Auto**.

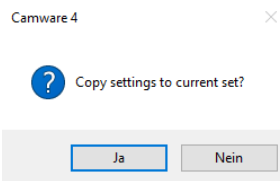
Camera Setting: All presets, such as resolution and frame rate, made in the **Camera Properties** (see 6.3) are saved to **Camera Settings**. Define different **Settings** with different **Preferences** in **Camera Properties** for each of your experiments. Settings can be switched easily at any time (not during record) and can be copied to other cameras.



Link Preview Set to 'Preview'

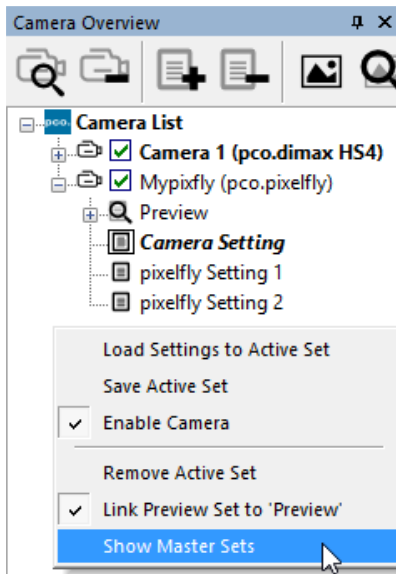
With **Link Preview Set to Preview** activated the **Preview set** with its parameters is always active when starting a **Live Preview** ⑤.

In case this function is deactivated the **Live Preview** always shows live images with the parameters of your **active setting**. This feature is beneficial if preview light conditions are different from those in recording situations.



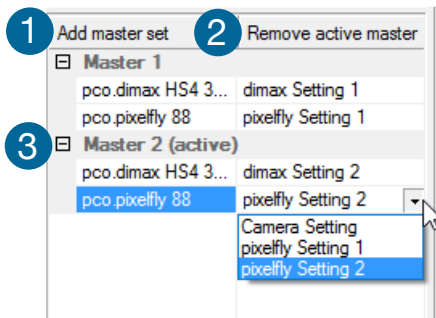
Click and drag camera setting: If you want to copy e.g. **Camera Setting 1** to **Camera Setting 4**, just drag **Setting 1** to **Setting 4** and Camware will ask you if you want to copy the settings. It is possible to copy each setting to every camera.

Master Sets



This function facilitates the image acquisition with multiple cameras. Defining two or more **Master Sets** allows easy switching between different predefined settings for each camera during an experiment. Each image acquisition or experiment can be recorded with its own **Master Set**.

To display Master Sets, please right-click in the **Camera Overview** window and select **Show Master Sets**.



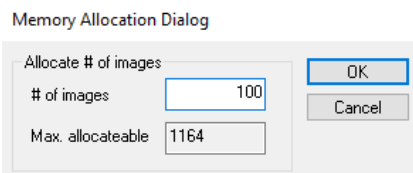
Master Set window

Define different Master Sets. Select individual **Camera Settings** within each **Master Set**.

Functions:

Add **Master Set 1** or **Remove active master 2**. Activate it by clicking on one set **3**.

Important Setting (for cameras without internal memory)



Memory Allocation Dialog

Change the **number of recorded images** in Camware, open the **Acquisition Tab** (see 6.9.4) and choose **Recorder Memory Settings**.

It sets the number of images recorded in one sequence. The maximum is defined by approved RAM size.

6.3 CAMERA PROPERTIES

The **Camera Properties** window in Camware is the main interface for all camera settings. The active set selected within **Camera List** is adjusted here.

The former topic **Camera Control** (known from Camware 3.x) and the **Convert Control** (see 6.3.6) can be opened additionally.

Three view options with various functions can be selected: **Basic**, **Custom** and **Expert**.

1 Basic mode only shows camera name, type, current set, serial number and exposure time. In **Basic Mode** the frame rate is always calculated automatically based on the selected exposure time, i.e. While exposure time is increased, frame rate decreases. It is recommended for Camware beginners.

2 Custom mode shows several more setting possibilities and functions can be hidden or shown by the **Custom Properties Button**. **4** Additional to the **Basic** mode, Trigger mode, Image Size and Recording control options are selectable.

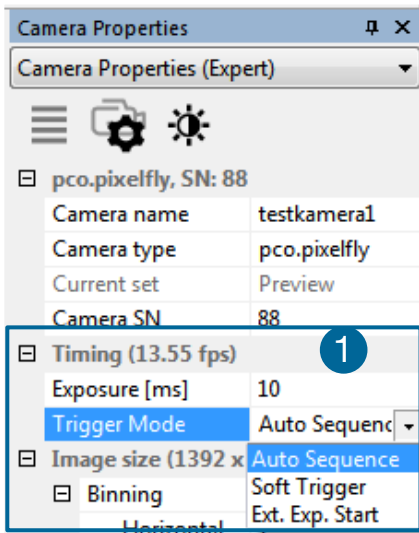
3 Expert mode (for advanced users) shows all possible **Camera Properties** settings.

An **explanation** for every setting is displayed below the properties dialog.

Exposure [ms]
Specifies the exposure time

6.3.1 TIMING

Trigger Modes ①



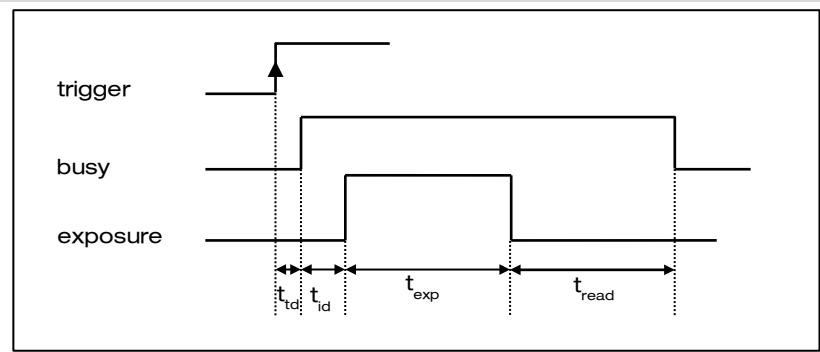
Auto Sequence: the camera optimizes the image recording to achieve the best possible frame rate.

In the **Auto Sequence** mode, the camera achieves the highest possible frame rate against the set exposure time and the time required for a frame readout. Upon a start command images are recorded until a stop command.

Software Trigger: single images are recorded by this Camware command. A single image is acquired by pressing the Single Trigger button. This button appears after pressing the Start Record button (see 6.5). Other signals have no influence at this operating mode.

External Exposure Start: image acquisition is triggered by an external signal. The single trigger button acquires a single image for a test.

In the **External Exp. Start** exposure control mode, single image acquisition is started by the **rising/falling edge** of the voltage signal at the BNC input (see appendix A1.4, A2).

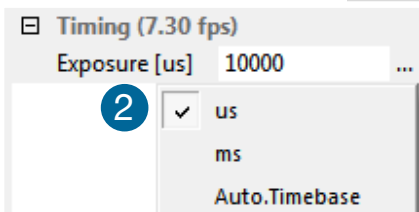


t_{td} : trigger acknowledge delay
 t_{read} : readout time

t_{id} : intrinsic delay
 t_{exp} : exposure time

pixel clock	intrinsic + trigger acknowledge delay
12 MHz / 24 MHz	5.6 μ s

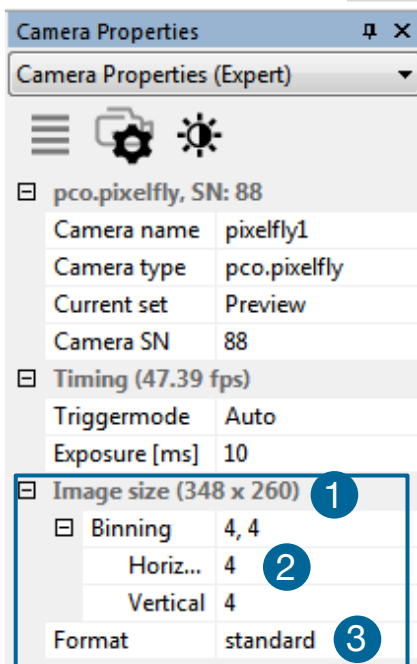
Exposure Time and time-base ②



Time-base may be changed from automatic to μ s or ms. If your input is out of the range of the camera, it will be automatically changed to the nearest possible setting. The current frame rate (fps) is always displayed. The exposure time (delay time setting is not available for pco.pixelfly usb) can be set in steps of 1 μ s. The jitter of the actual exposure start edge: < 13 ns.

camera type	exposure time
pco.pixelfly usb	1 μ s ... 60 s

6.3.2 IMAGE SIZE



The actual image size **1** is displayed here. **Binning** or **Region of Interest** settings affect the image size and are applied automatically.

Binning **2**

Binning combines adjacent pixels (in either the horizontal or / and vertical direction) to form super pixels. It increases the light signal of the resulting pixels and decreases the spatial resolution of the whole recorded image.

Since the readout is done only once for all binned pixels, the signal to noise ratio increases. Vertical binning will also increase the readout speed (x2 vertical binning = double frame rate).

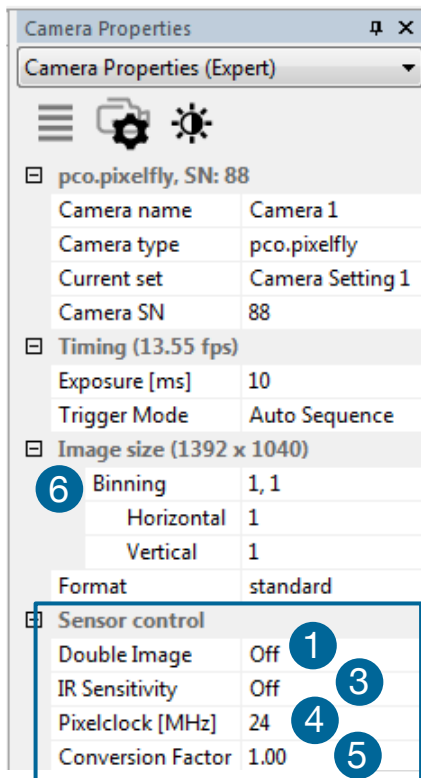
Available Binning Modes:

H1xV1, H1xV2, H1xV4, H2xV1, H2xV2, H2xV4, H4xV1, H4xV2, H4xV4

Sensor Format **3**

A sensor's feature provides the option to either read out the standard size (full resolution) of 1392 x 1040 pixels (effective pixels recommended by the sensor manufacturer) or an alternative size of 800 x 600 pixel (center mode).

6.3.3 SENSOR CONTROL



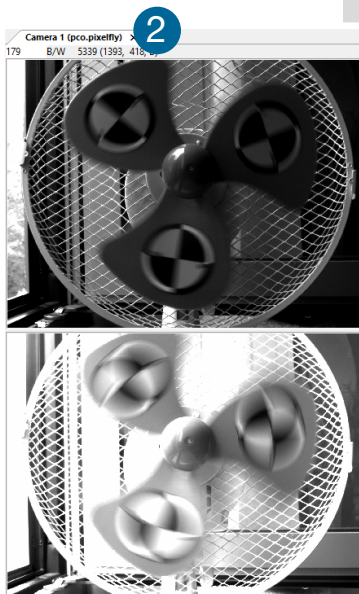
Sensor Control allows controlling of all sensor specific settings.

Double Image / Doubleshutter (optional) ①

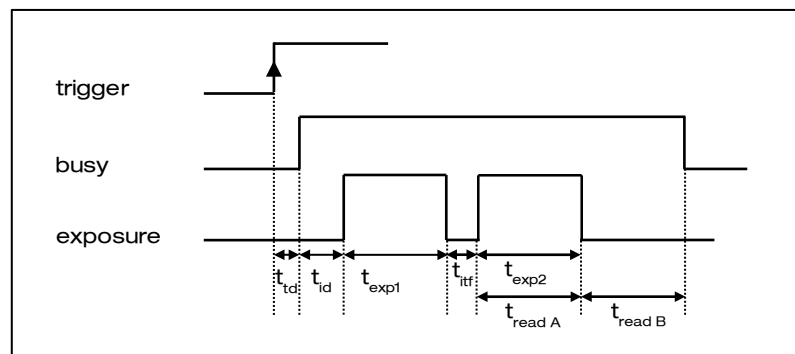
This feature is widely used for particle image velocimetry (PIV) measurements and is an **optional feature**. The first exposure time t_{exp1} may be any exposure time of the available range of the pco.pixelfly usb camera. The second exposure time t_{exp2} can not be directly adjusted. The length of the second exposure is exactly the readout time t_{readA} of the first image. The interframing time t_{itf} denotes the transition time between end of exposure #1 and start of exposure #2. Readout times t_{readA} and t_{readB} are exactly the same. See also appendix A1.4.

	12 MHz	24 MHz
$t_{td} + t_{id}$	5.6 μ s	5.6 μ s
t_{exp}	1 μ s ... 60s	1 μ s ... 60s
t_{read}	137 ms	74 ms
t_{itf}	1 μ s	1 μ s

While recording in Double Shutter mode, Camware will automatically **split the view window** ② and always shows both images side by side.

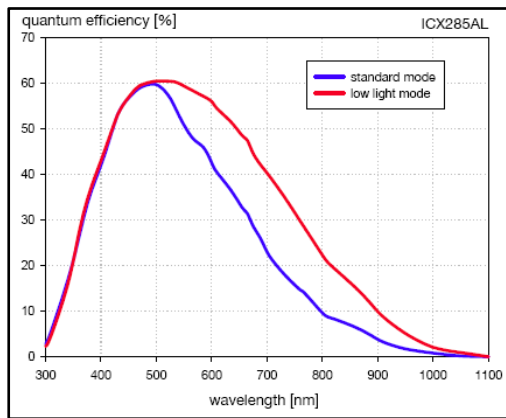


Double Shutter timing



t_{td} : trigger acknowledge delay t_{id} : intrinsic delay
 t_{exp1} : exposure time 1st image t_{readA} : readout time 1st image
 t_{exp2} : exposure time 2nd image t_{readB} : readout time 2nd image
 t_{itf} : interframing time

IR Sensitivity ③



This feature uses a special image sensor control method, allowing greater sensitivity in the near infrared spectral range (red line in graph), in most cases at the expense of decreased anti-blooming performance.

Minimum exposure time is 5 ms. It is recommended to use the IR sensitivity mode for long exposure times >120ms

The integrated **hot pixel correction** is not correcting the **additional IR hot pixels**.

If you need to correct hot pixels in IR mode, please follow instructions in chapter **6.9.3** (Create Hot Pixel List). Or see **A2**.

Pixel Clock ④

Pixel clock sets the clock frequency and therefore the image sensor readout speed.

At 12 MHz the image quality will be higher due to very low readout noise.

At 24 MHz the image sensor is read out with nearly double speed, achieving higher frame rates.

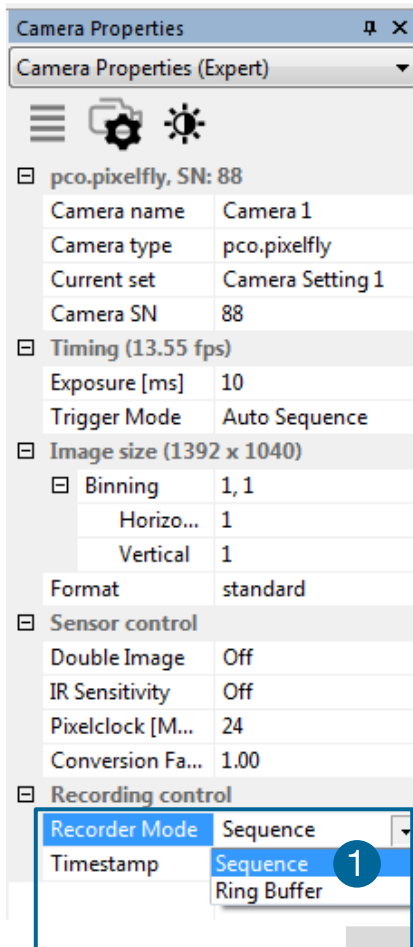
Resolution	12 MHz	24 MHz
1392 x 1040	7.3 fps	13.5 fps
800 x 600	11.7 fps	21.6 fps

Conversion Factor ⑤

The conversion factor defines how many charges (electrons), generated by light in each pixel, are necessary to generate one count (one intensity level) in the digital image. Therefore, the conversion factor describes the gain when converting electrons into a digital value.

The pco.pixelfly has two conversion factors: 1.0 e⁻/count and 1.5 e⁻/count, which both can be used in **1x1 (full resolution)** ⑥ and higher binning modes. As mentioned in **6.3.2** binning is available for the pco.pixelfly. The usable extended fullwell-capacity rises in binning mode from 16000 to 24000e⁻. In **1x1 (full resolution)** it makes sense to keep 1.0 e⁻/count. Changing the conversion factor to 1.5e the high dynamic of 16384 grey steps is not usable. In **binning mode** you can use both conversion factors: having a lowlight scene the 1.0 e⁻/count mode helps to spread the low image information contentz – in normal light scenes it makes sense to use 1.5e⁻/count for full dynamic availability.

6.3.4 RECORDING CONTROL



Recorder Mode ①

In **Sequence** mode the recording stops upon reaching the number of images allocated in RAM. (See 6.2). In **Ring Buffer** mode the camera will stop only by a stop command. In this mode the RAM is a circular buffer and continuously overwritten, starting at the first image.

Timestamp ②

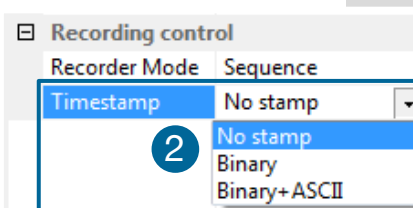
A time stamp can be placed into the upper left corner of the image. It can be either **no stamp off**, **binary** or **binary with text**. Time resolution is 1µs.

In binary mode the first 16 pixels will be filled with the time stamp information (binary code). The numbers are coded in BCD with one byte per pixel, which means that every pixel contains 2 digits. If the pixels have more resolution than 8 bits, then the BCD digits are right bound placed and the upper bits are zero. For further information please refer to the SDK.

In binary and ASCII mode text will be placed into the image replacing the content of the image (271x 8 pixels).

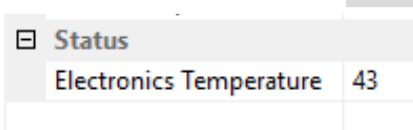
Time stamp shows the **end** of exposure time.

Three different **information** is stamped onto the image: image number ③, date ④ and time ⑤.



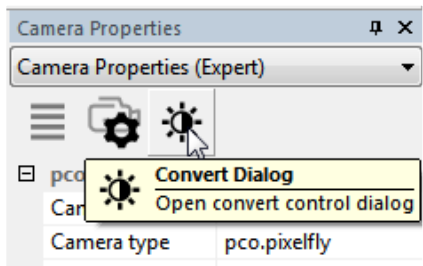
Additionally to **Timestamp** the **Image overlay** function is available, see chapter 6.4.

6.3.5 STATUS



Shows the current temperature level of the pc0.pixelfly usb camera.

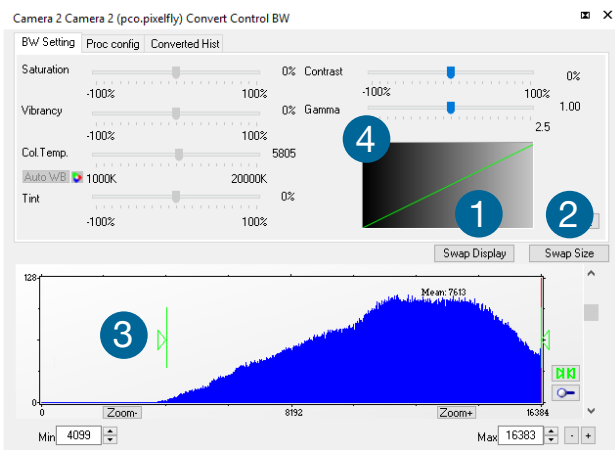
6.3.6 CONVERT CONTROL DIALOG



Start the **Convert Control Dialog** with the **Black / White Button** in Camera Properties.

Convert Control BW

The user can manipulate the display of the original 14 bit image intensity values (x-axis) in the displayed 8 bit values (y-axis).



BW Settings (includes histogram of original data)

It is possible to hide the histogram of original data **1** **and to** switch tab / histogram **2**.

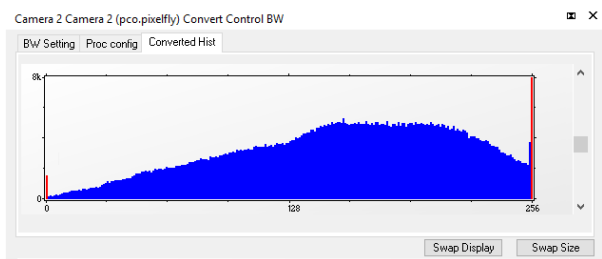
Green sliders in histogram 3

left slider = Min controller (corresponds to value 0 of the 8 bit display). Values below that mark are set to 0, i.e. displayed as black.

right slider = Max controller (corresponds to value 255). Values above that mark are set to 255, i.e. displayed as white.

The values in-between are converted into a value between **0** and **255** according to **Contrast** and **Gamma** settings. The small **graph 4**, reflects the calculation.

Proc config tab: please see under Convert Control Color

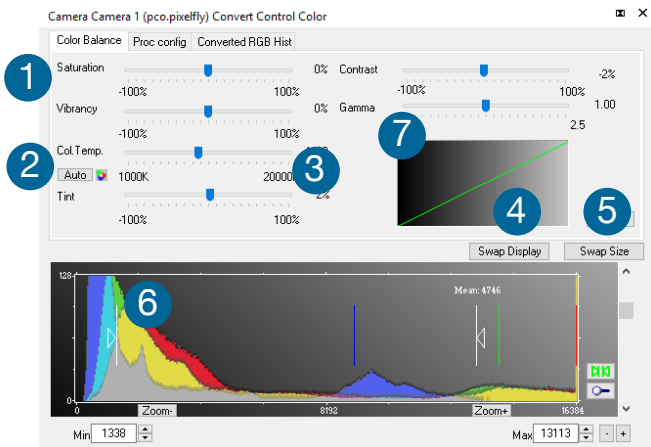


Converted Hist

This tab shows the **histogram of converted data**.

Other functions (Saturation, Vibrancy, Col.Temp, Tint) **are inactive** for **monochrome** cameras

Convert Control Color (only pco.pixelfly usb color)



Color Balance (Histogram of original data)

Intensity of a single color is controlled by **Saturation** and **Vibrance** ①

Press the Auto button to set the **white balance** ②.

The balancing of RGB is controlled by **Col.Temp** and **Tint** ③

It is possible to **hide the histogram of original data** ④ and to **switch tab / histogram** ⑤

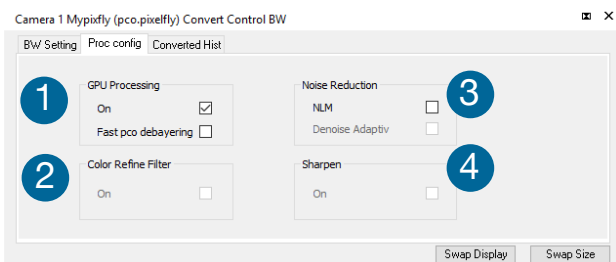
The user can manipulate the display of the original 14 bit image intensity values (x-axis) in the displayed 8 bit values (y-axis).

White sliders in histogram ⑥

left slider = Min controller (corresponds to value 0 of the 8 bit display). Values below that mark are set to 0, i.e. displayed as no color.

right slider = Max controller (corresponds to value 255). Values above that mark are set to 255, i.e. displayed as full color.

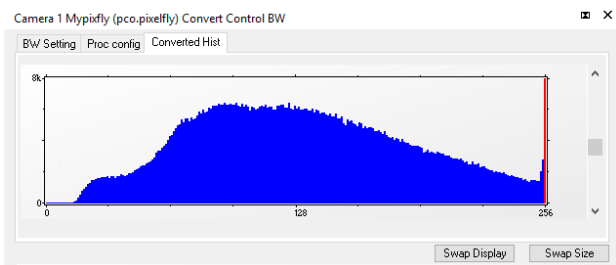
The values in-between are converted into a value between 0 and 255 according to **Contrast** and **Gamma** settings. See the small **graph** ⑦, which reflects the calculation.



Proc. Config (Process configuration)

Due to proprietary high-end algorithms used for these image processing features, no detailed description is given here.

- | | |
|---|---|
| ① | GPU Processing
On: Switch on in order to significantly reduce processing time (increases refresh rate of the live image)
Fast pco debayering: only color cameras |
| ② | Color Refine Filter only color cameras |
| ③ | Noise Reduction
NLM: Non local means algorithm
Denoise Adaptive: only color cameras |
| ④ | Sharpen:
On: only color cameras (first activate Fast pco debayering) |



Converted Hist

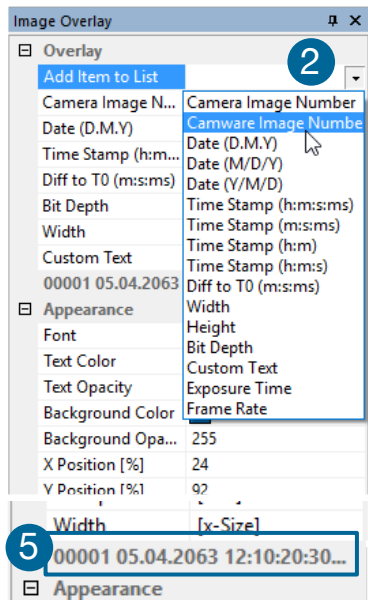
This tab shows the **histogram of converted data**.

6.4 IMAGE OVERLAY



Open **Image Overlay**: these two buttons allow easy switch between **Camera Properties** and **Image Overlay**. **1**

If not available, please see **6.9.5 View Menu** to activate this menu.



This function enables an **individually configurable image overlay** allowing to display information within the images.

Many different options are available by clicking **Add item to...** **2**

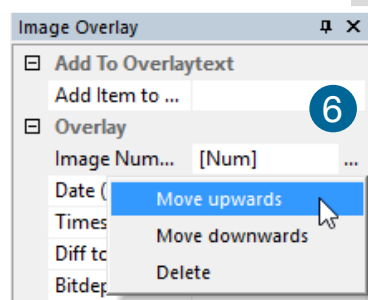
Also the **Appearance** is configurable:

Font, Text color, Text opacity, Background color, Background opacity and horizontal or vertical orientation.

Camera image number **3** and **Camware Image Number** **4** are two different count methods:

Camera image number: the image numbers are incremented continuously. When recording in Ring Buffer mode, the image numbers exceed the number of images stored in the RAM memory of the computer since images are overwritten when the memory is full, starting with the first image in loop.

Camware image number: the software displays the image numbers according to the number of images being recorded (starting with image 1).



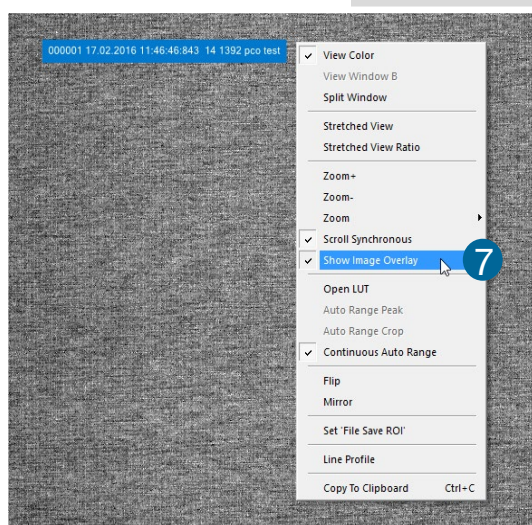
006964 000001 26.06.2017 10:54:48:521 12 1584 pco

A preview of the image overlay is shown. **5**

Each item can be moved upwards, downwards or deleted by clicking on **...** **6**



By **drag & drop** the **Image Overlay** can be moved easily to your favorite position within an image.



To activate image overlay **right-click** in the image window and activate **Show Image Overlay**. **7**

NOTE

This function does not overwrite image data.

6.5 RECORDER TOOLS

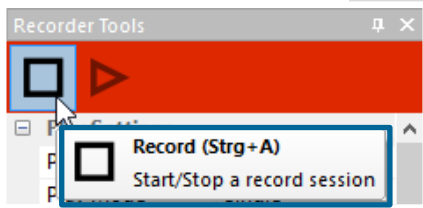
Recorder Tools provides **Record** and **Play** function, **Play Settings** and **Record Settings**.

It can be found on the right lower side of Camware or, if closed, activated by **View Menu** (see chapter 6.9.5)

Record

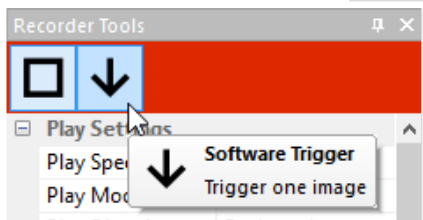


Start/Stop record: with Record Button **or** press **enter** in the **View window** to **Start/Stop a record session**.



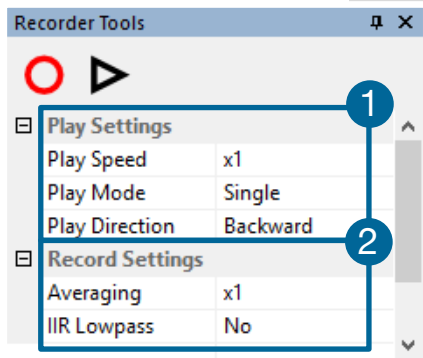
Record: in record state Camware software is highlighted in red.

Exposure time may be changed during recording. See 6.3 **Camera Properties**.



Software Trigger Mode: after record is started an arrow pointing downwards appears, which releases a single trigger (see 6.3.1).

Play Settings ①



Play Speed: selectable play speed from x1 to x256 or from 1fps to 16fps. E.g. in mode x1 a recording with 1000 fps is played with 25fps.

1 fps means that only one frame per second is played.

Play Mode: selectable play mode of the recorder (continuous or single time (re)play).

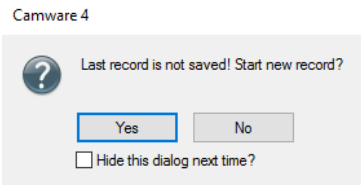
Play Direction: selectable direction of record play (forward or backward)

Record Settings ②

Averaging: If in the dropdown list a value not equal to x1 is selected, the corresponding number of images is averaged in the buffer, reducing the statistically independent noise.

IIR Lowpass: Another option to reduce the noise is the activation of the **Infinite impulse response IIR lowpass filter**. This filter takes 90% of the previous image and 10% of the new image to create images with clearly reduced noise.

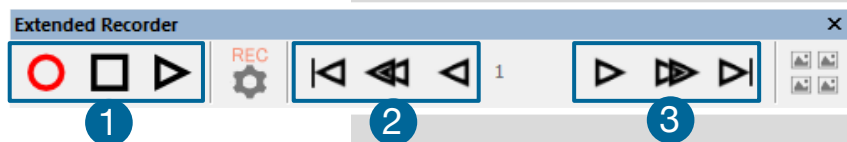
$$\text{Image (actual)} = \text{Image (act - 1)} * 0.9 + \text{Image (new)} * 0.1$$



Reminder dialog

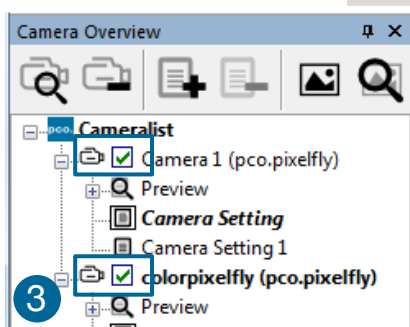
If you have already made a recording but did not save it, Camware will ask you to save the record before starting a new one.

Extended Recorder can be activated (see 6.9.5)



Functions:

- ① Start & Stop record / Stop record / Replay
- ② First image (jump to first image) / Back fast (jump backward) / Back (jump one image backward)
- ③ Forward (jump one image forward) / Forward fast (jump forward) / Last image (jump to last image in record)



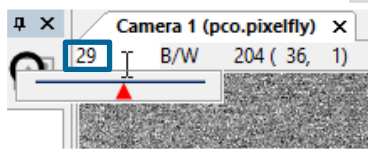
Recording with multiple cameras

With all cameras activated recording is started simultaneously for all cameras.

Recorder will use Recorder mode settings (Sequence or Ring Buffer) of the **active** camera for all cameras (see 6.3.4)

For single camera recording, deactivate cameras by removing the check mark from the box. ③

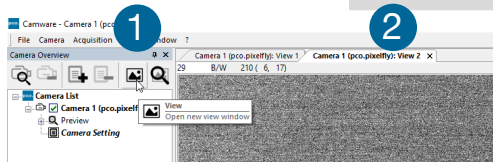
6.6 VIEW WINDOW



Fast-scroll through images

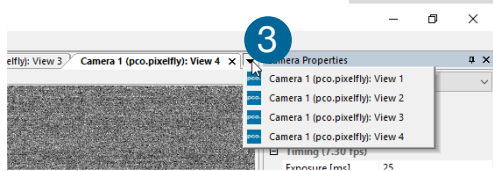
If you have recorded at least 50 images, you can scroll through the images quickly. To do this point the mouse to the red flag and slide it. Additionally you can enter the **desired image number** directly into the number field.

More View Windows



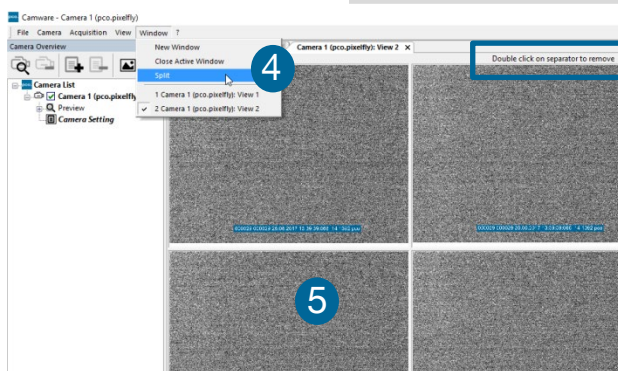
It is possible to open more view windows from one camera: just **open new view window** ① and Camware will create a new one ②.

Even when multiple view windows (or from multiple cameras) are open, the same image number is always shown in all of the view windows.



A **dropdown menu** ③ helps to select a view window. If there are more view windows than can be displayed on the desktop, you will be able to select each view window.

Split View Window



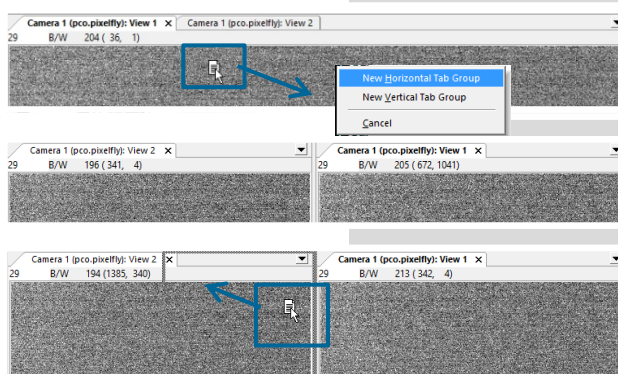
The view window can be split. Choose **Window** → **Split** ④ and a split cross will be shown. The size of splitted window elements is easily adjusted by grabbing and dragging the dividing lines ⑤.

The main reason for this function is to view four sections of the image in one view. Choose the **Zoom±** function to zoom in the image (first turn off **Stretched View**, see 6.9.8)



To undo the split, double click on the separator line (once the symbol ⑥ becomes visible).

Two Tabs side by side or on top of each other

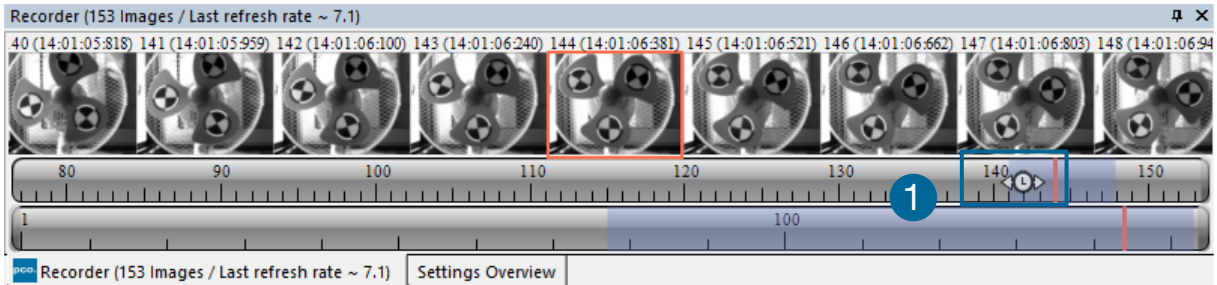


To view two tabs side by side or arranged one above the other just drag a tab and then Camware will ask whether you want to create a new horizontal or vertical tab group. Undo this very easily by dragging the tab back to its former position.

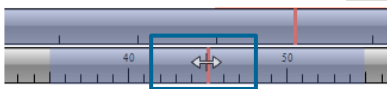
This also applies for view windows of several cameras.

6.7 RECORDER (IMAGES)

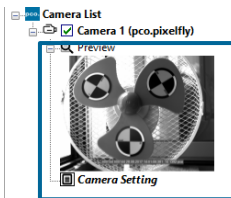
When recording is done, **small preview images** (thumbnails) are built and displayed automatically in the **Recorder docking window**. This will take some time depending on the performance of your computer system and of the interface used.



If you click (left mouse button) within the upper scale bar **1**, you can adjust the number of images which are shown by moving the mouse left or right. Minimum is **20** and maximum is **half of the recorded images** in this scale.



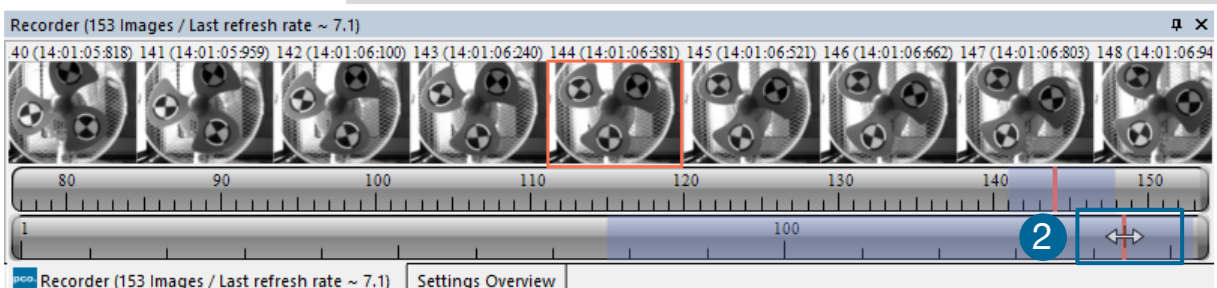
Quick scrolling: you can quickly scroll through the thumbnails by dragging the orange bar with the mouse or by **mouse wheel** while the cursor is over the image number bar.



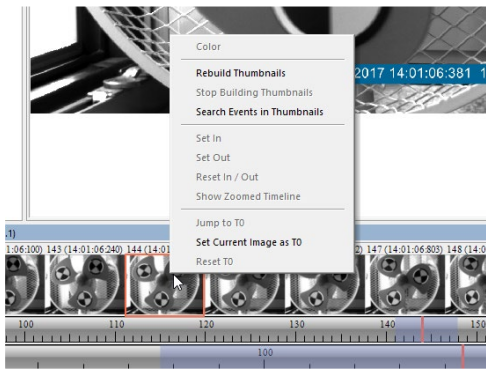
While quick scrolling, the **Preview** window will display the active image sequence. This allows to quickly scroll through the image sequence displaying the images in the **Preview** window forwards or backwards. The **View** window will not actively show live images during quick scrolling (only in normal scrolling speed by mouse-wheel).

Clicking on a thumbnail image it will be shown in the view window. Scroll **via mouse wheel** through the thumbnails.

The upper **blue bar** correlates to the number of displayed thumbnails. The lower blue bar shows the range of the upper scale in relation to the whole record.



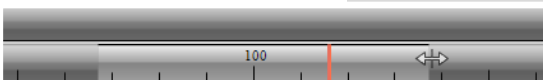
The second scale shows the total number of recorded images. It allows fast scrolling through the recorded images **2**



Right-click menu (click on thumbnails)
Allows to rebuild all thumbnails and to search for events.

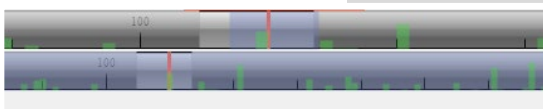
Furthermore, **Set In / Out** enables to set values for a sequence, which can be played via play button. Reset In / Out discards these settings.

Set In / Out is active: if you **save / export** images, only the selected images are saved / exported (see 6.9.2).



The **light gray area** in the upper scale shows an **In-Out** example area. Define easily a new area: just **right-click on the start and end frame** in one of the scales. The **In** image must be left side to the red bar, the **Out** image on its right side.

Adjust the In / Out area by holding down the left mouse button and sliding the borders to increase / decrease.

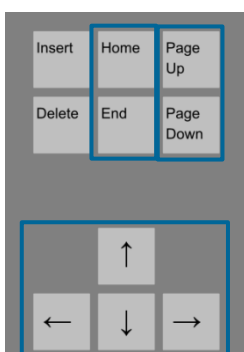


Search Events in Thumbnails: detected events are displayed as **green bars**.



Too dark or bright thumbnails: if thumbnails are too dark or too bright, right-click in view window (see 6.9.8) and select **Auto Range Peak** or **Auto Range Crop**. Then

right-click on a thumbnail image and select **Rebuild Thumbnails**. Now the thumbnail images should comply with the view window.



Use your keyboard to scroll through the Images:

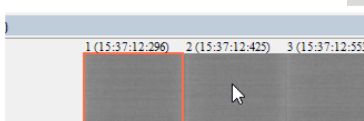
Page up / down keys: 10 Images up or down.

Arrow keys: quick scrolling through the images.

Advantage: fluent video playback in the **View window** (forwards or backwards).

Home/Pos1 key: first image.

End key: last image.



Additional short-cuts:

While mouse is in the thumbnail area in **Recorder (Images):**

Press CTRL + left mouse button to jump to the **first** image

Press CTRL + right mouse button to jump to the **last** image

6.8 SETTINGS OVERVIEW

Camera	Auto Save	Type	Status	Frame Rate	Resolution	Exposure Time	No. of Images	T0 Pos.	Ext. Sync. State
Camera 1	<input type="checkbox"/> Off	pco.pixelfly (86)	Ready	14	1392 x 1040	10ms	51	-	-
Camera 2	<input type="checkbox"/> Off	pco.ultraviolet (10200023)	Ready	7	1392 x 1040	10ms	51	-	-

Settings overview shows the most important parameters of your camera(s) at a glance. If you have more than one camera connected, each camera and its parameters are listed.

The parameters can only be changed using **6.3 Camera Properties**.

It is possible to easily switch between the **Recorder (Images)** section and the **Settings Overview**. **11**

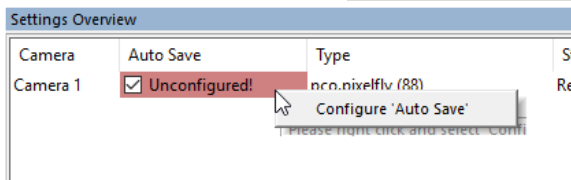
No.	Function	Description
1	Camera name	Name
2	Auto Save	Off , Unconfigured (red), OK (green)
3	Type	Camera type and serial number
4	Status	Ready or Recording Green background: Images are in memory
5	Frame rate	Currently selected frame rate
6	Resolution	Resolution in pixels
7	Exposure time	Selected exposure time
8	Number of images	Number of images to be recorded
9	T0 Position	Not available for pco.pixelfly usb
10	Ext. Sync. State	Not available for pco.pixelfly usb

6.8.1 AUTO SAVE

Auto Save makes it easy to save recorded images or sequences. There is no need to save each image / sequence separately from each connected camera. Therefore this function is very useful if you use more than one camera. Once configured **Auto Save** allows acquiring and saving as many images / sequences as many images/sequences of your experiment as desired. This function stores RAW (e.g. TIFF) and Export (e.g. AVI, JPG) files.

Standard file save see File Menu **6.9.2**.

Explanations will be displayed in the **Info Text** window at the bottom of the menu.



Enable **Auto Save** by clicking on the check box. The text will change to **Unconfigured!** (red background).

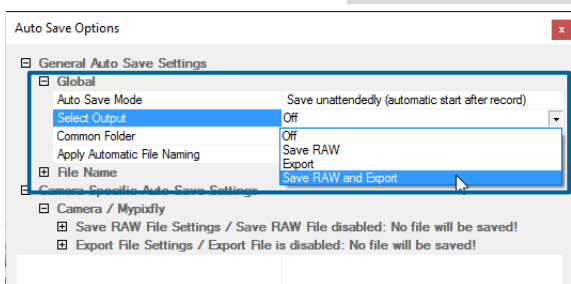
Right-click on the **Unconfigured!** field and click on **Configure 'Auto Save'**. The **Auto Save Options** dialog will be displayed.

First, configure the **General Auto Save Settings - Global**

Auto Save Mode: two different modes are available, **Save manually** and **Save unattendedly**.

Save manually mode stores RAW images and exports them after a recording session by pressing **ALT and D** keys. This allows to cut an image sequence in the **Recorder Toolbar** before saving.

Save unattendedly mode downloads all RAW images and exports the complete image sequences of all cameras immediately after an active recording is stopped.



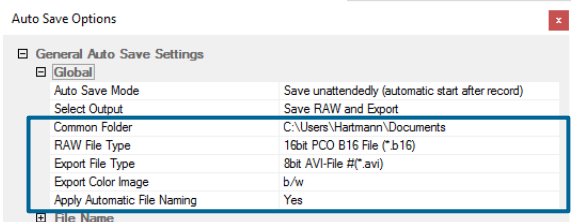
Select Output:

Off – Auto Save is deactivated

Save RAW – only 16 bit RAW files are stored (b16, pcoraw, MultiTif-File, Tiff)

Export – only compressed files are stored (BMP, JPG, Tiff, AVI, MPEG, WMV)

Save RAW and Export – RAW and compressed files are stored simultaneously



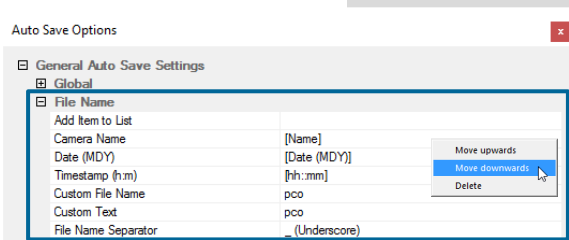
Common Folder: main folder for stored files

RAW and Export file Type: select the type of RAW and compressed file

Export Color Image: select if you want to export color images (only for color cameras)

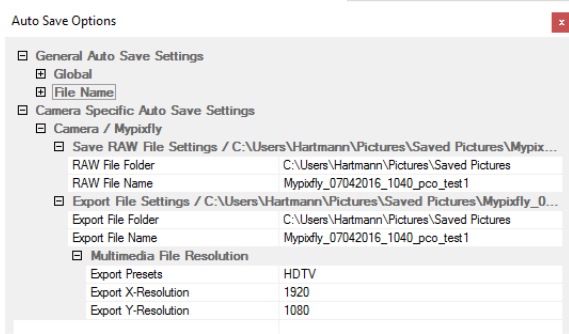
Apply Automatic File Naming: if set to **yes**, your stored files are automatically named by Camware according to your automatic file name settings.

General Auto Save Settings – File name



Set your file name individually by adding or deleting items. Position these elements as needed.

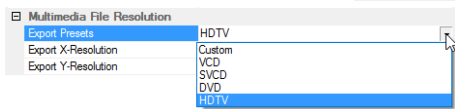
Camera Specific Auto Save Settings:



Configure camera specific settings for each connected camera.

Save RAW File Settings: set **RAW File Folder** and **RAW File Name** (if not set to automatic file naming).

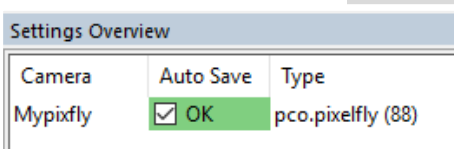
Export File Settings: set **Export File Folder** and **Export File Name** (if not set to automatic file naming).



Multimedia File Resolution: set predefined video export resolution or enter a **Custom** x- and y-resolution. It makes sense to set the resolution to the actual camera's resolution.



Finish the configuration by clicking **OK**.

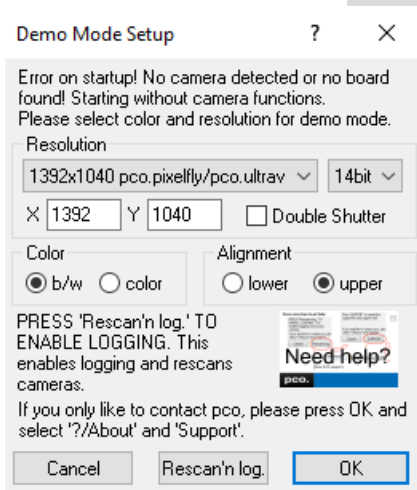


After configuration is finished, **Auto Save** status will be set to **OK** (green background).

6.9 CAMWARE MENU TABS & FEATURES

This chapter describes in detail the Camware Demo Mode and the Camware Tabs: File, Camera, Acquisition, View and Window. Furthermore the right-click menu and some additional features are listed.

6.9.1 DEMO MODE



Upon start Camware, it automatically recognizes the camera type of the connected and running cameras.

Camware starts in Demo Mode, if your camera is switched off or no camera is connected.

In this mode all **image processing** features are available, but all **camera settings** are deactivated. Just tell Camware the type of image you want to open. For that purpose, the **Demo Mode Setup** window opens and asks for the corresponding input. All camera options are deactivated.

Need Help? Having troubles to run the camera, this window will pop up. See instruction in appendix **A4**.

Settings to view the b16 files of the pco.pixelfly usb

Resolution	bit	DoubleShutter	Color	Alignment
1392 x 1040	14	yes / no	b/w or color	upper

Resolution

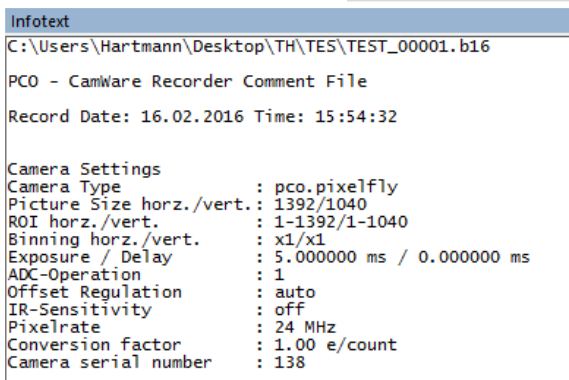
The drop down list displays the PCO camera image sensor resolutions. Select the specific resolution and bit depth of the images to be opened. If double shutter images have been recorded, Double Shutter Mode should be ticked.

Color

Select color mode.

Alignment

Adjust whether MSB (most significant bit) aligned (upper) or LSB (least significant bit) aligned (lower) images have been stored.



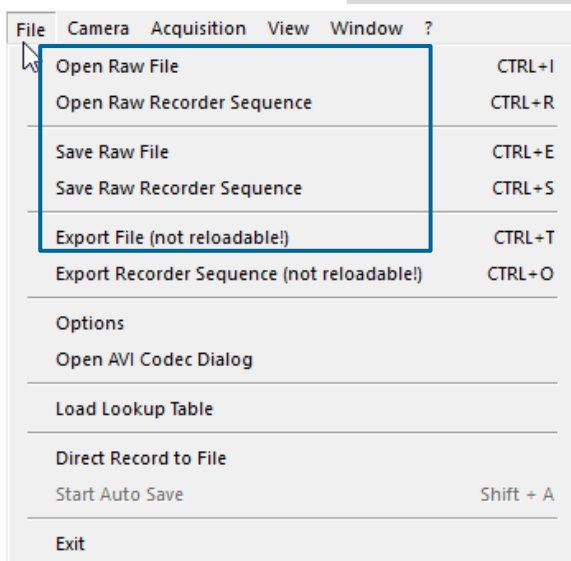
Infotext

The **Infotext** is automatically shown in Camware when a stored image sequence is opened..

The **Camera Properties** settings, storing location and Record date are listed in this file.

Infotext can be activated in the View Menu **6.9.5** at any time.

6.9.2 FILE MENU



NOTE

Be aware of the different storage abilities of the formats, for example *.bmp - the bitmap format only allows for 8bit values to be stored and therefore the image content of a 16 bit image is reduced, if stored as bitmap.

Open RAW File (single image only)

This command should be used to import a single image into the currently active image window. Only files with the extension and format of ***.b16 (=PCO proprietary binary image format)** and *.tif (16 bit TIFF image format) can be imported. If the recorder is enabled, each imported image will be transferred to the buffer shown in the picture number. The image itself will be fitted to the current image size. If the recorder is disabled, the current image size will be set to the parameters of the imported image.

Open RAW Recorder Sequence (image sequence from one camera)

This command is used to import a sequence of images. If more than one camera is connected and an image window is currently open, the sequence will be loaded to the active window. If no image window is open, the images will be loaded to camera #1. This command opens the Open file dialog box. Only files with the extension and the format of ***.b16**, ***.pcoraw**, ***.tif** and **multi tif** can be imported.

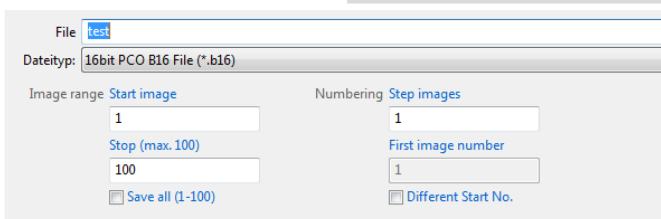
Save RAW File (single image only)

This command should be used to save the image, which is displayed in the active window. The command opens the Save file dialog box. The image file can be saved in **16bit *.b16** and ***.tif** format. If more than one camera is connected, it is possible to save all current images by selecting Export all images in the Save file dialog box. This feature allows to save one image of each active camera within one process step (it is not necessary to repeat the save process for each camera). The Save command will not be available, if no image window is open. For **Auto File Save** see **6.8.1**

Save RAW Recorder Sequence (image sequence from one camera)

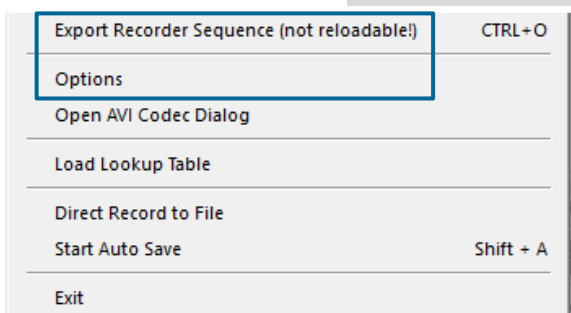
This command should be used to save or export image sequences. If more than one camera is connected and an image window is currently open, the record of the active window will be saved. The command opens the Save recorder file dialog box. It is possible to select the number of saved images, to step images and to choose the

first image number. For **Auto File Save** see **6.8.1**



Export File (not reloadable!)

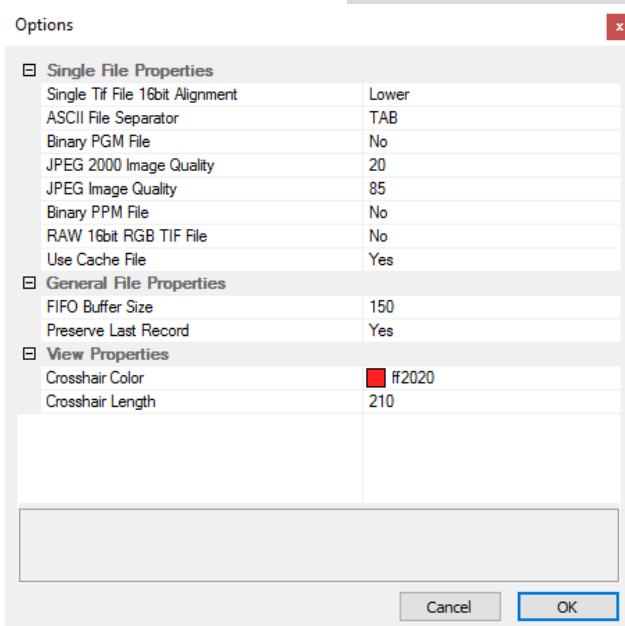
Use this command to export the image of the active image window. This command will open the Export Image dialog box. Files with the extensions fts, tif, bmp, asc, jpg, and jp2 can be exported. This item will not be visible, if no image window is open. For **Auto File Save** see **6.8.1**



Export Recorder Sequence (not reloadable!)

Use this command to export a sequence of images. If more than one camera is connected and an image window is currently open, the record of the window which has got the input focus will be saved. If no image window is open the Export Recorder Sequence menu does not appear. This command opens the Export recorder box. Files with the extensions fts, tif, bmp, asc, avi, mpg, jpg, jp2, and wmv can be exported (see Appendix A4). For **Auto File Save** see 6.8.1

Options



Single File Properties

Single tif file 16 bit alignment: upper / lower
ASCII File Separator: select a separator for the values in the ASCII file. Select: tab, space, semicolon, colon, comma, hyphen, slash, backslash.

Binary pgm file: set the format of the pgm (portable gray map) file. Select: yes, no.

Jpeg2000 image quality: set compression from 20 to 100%.

Jpeg image quality: set compression from 20 to 100%.

Binary ppm file: set format of the ppm (portable pixmap) file. Select: yes, no

RAW 16bit RGB tif file: save raw tif without color balance. Select: yes, no.

Use cache file: Caches image data on disc for a camera with camera internal memory. Select: yes, no (not available for pco.pixelfly usb)

General File Properties

FIFO buffer size: set the FIFO buffer size in number of images. This helps to avoid gaps during file write delays. Usually this is set to 150.

Preserve last record: preserve current recorded images. When set, the user will be asked whether to really start a new record or to close.

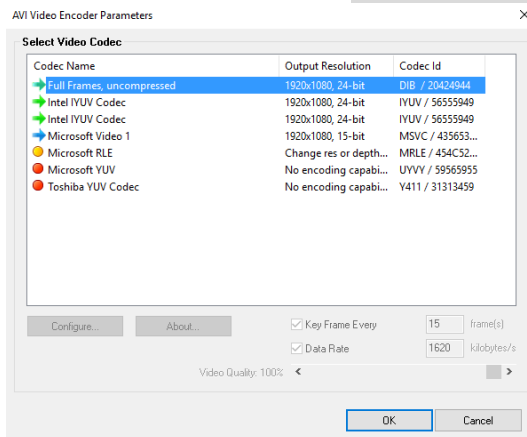
View Properties:

Crosshair color: set the color for crosshair, save ROI and line tool.

Crosshair length: set the crosshair length in pixel.

Activate crosshair: see chapter 6.9.8

Open AVI Codec Dialog



Settings in **Auto File Save** affect stored video sequences.

You only need to set this option, if you use **Auto File Save** see 6.8.1

Please select the (compression) codec you want to use for your stored sequences. All installed codecs are listed here.

Load lookup Table (for monochrome cameras)

This feature assigns pseudo colors (lookup tables) to a monochrome image. Either use one of the four predefined or create your own. The result is shown in the color view window.

Direct Record to File

This command presets a certain number of images to be stored. If the camera captures images faster than the computer can save to disk, you will lose images. Displaying of the images doesn't interfere with the record process.

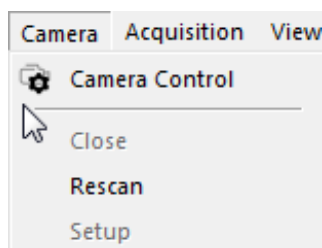
Start Auto Save

Only available if **Auto Save** is activated (see 6.8.1)

Exit

This command exits the program and closes all channel dialog windows. Window positions, settings and sizes are stored in the windows registry and will be loaded again at next start-up.

6.9.3 CAMERA MENU



Camera Control

Use this command to open the camera control window (see 6.2).

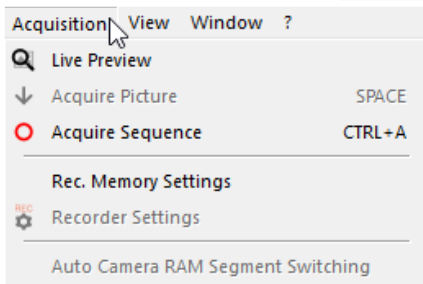
Close

Disconnects camera and switches Camware to Demo Mode. In case of multiple cameras, all cameras have to be closed individually for Camware to switch to Demo Mode.

Rescan Disconnects and reconnects all cameras.

Setup (not available for pco.pixelfly usb)

6.9.4 ACQUISITION MENU



Live Preview

The **Live Preview** is useful for fast and easy adjusting and focusing of the camera. The active window will be updated. To see another window, simply click on the window. This option is not available in double shutter mode.

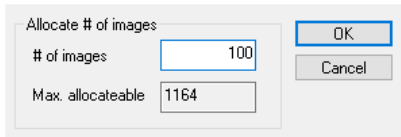
Acquire Picture

Active if Recorder Mode is set to **Soft Trigger**, see 6.3.1

Acquire Sequence

Starts recording images into the computer's RAM according to Trigger Mode selection (see 6.3.1). During recording, all camera controls are locked.

Memory Allocation Dialog



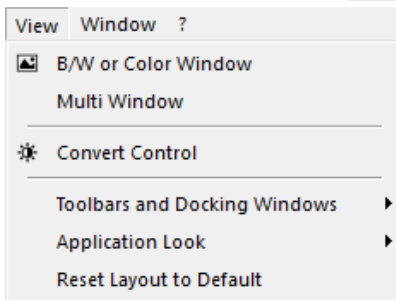
Rec. Memory Settings

This sets the number of images recorded in one sequence. The maximum is defined by pre-established RAM size.

Recorder Settings (not available)

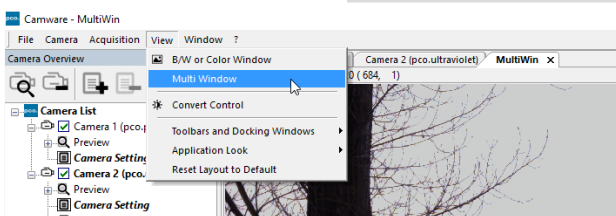
Auto Camera RAM Segment Switching (not available)

6.9.5 VIEW MENU



B/W or Color Window

Command to open a new display window.



Multi window

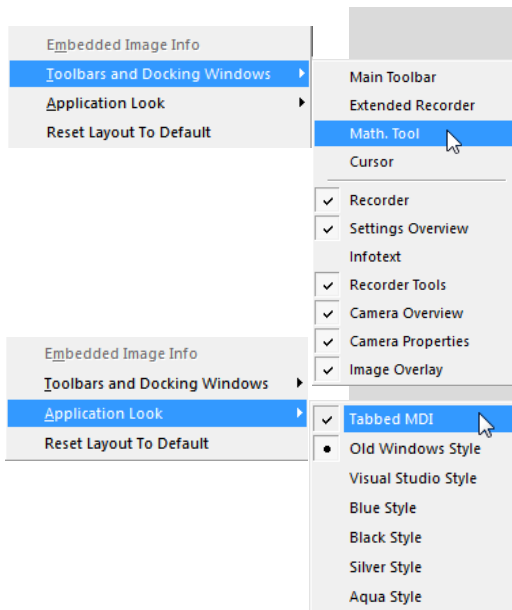
View the images of all active cameras in **consecutive order** in one window. This function provides an easy comparability of the views of different cameras.

Use the same ROI and timing settings for all cameras.

Only available when using more than one camera. After a complete sequence is recorded (sequence mode) or buffer is full for the first time (Ring Buffer).

Convert Control

See 6.3.6

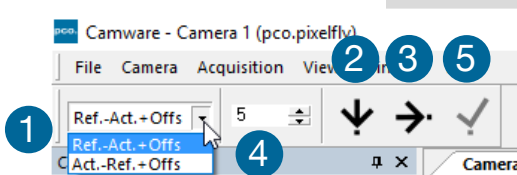


Toolbars and Docking Windows

Standard toolbars of Camware 4 are Recorder/ Recorder Tools / Camera Overview / Camera Properties and Image Overlay. **Additional Toolbars** are displayable, but not essentially needed: Main Toolbar / Extended Recorder / Math. Tool / Cursor. For function **Infotext** see **6.9.1**

Application Look

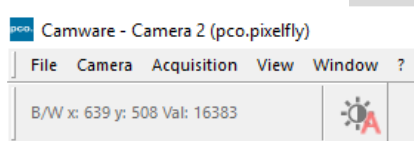
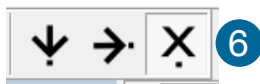
The Style and Look of Camware can be customized; many different style sheets are selectable. The Tabbed MDI function (un)docks the view windows.



Math Tools

With the math window you have the ability to calculate the difference between a reference image and the actual image. Activating math every new image acquired will be subtracted from the reference image or vice versa:

- 1 Reference (image) – Actual (image) + Offset or Actual (image) – Reference (image) +Offset
- 2 a reference picture will be acquired and copied to reference buffer
- 3 last acquired image will be copied to reference buffer
- 4 add offset to avoid negative values, which would not be visible
- 5 enable math function
- 6 disable math function



Cursor

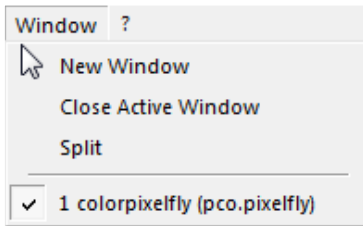
Shows position of mouse cursor.

Example: B/W (black/white camera) x-axis: 639; y-axis: 508; Value: 16383 counts

Reset layout to default

This resets all your customized changes and restores the default layout.

6.9.6 WINDOW MENU



New Window

Opens a new one.

Close Active Window

Closes the active one.

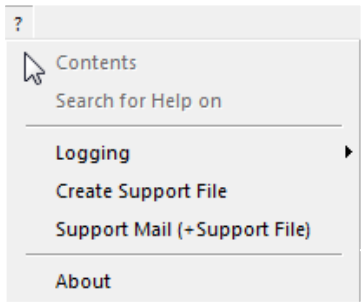
Split

The view window will be split in four quarters.

Camera overview

Shows all connected cameras, e.g. **1 colorpixelfly (pco.pixelfly)**

6.9.7 HELP MENU

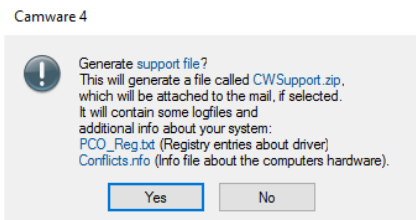


Contents

Opens the main page of the program help.

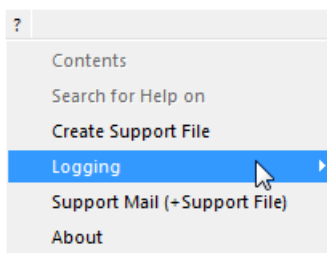
Search for Help on

Opens an index list for help.



Create Support File

Press YES to activate the Camware log files, reboot Camware and your pixelfly.usb. With activated log files it is possible to create a support file. Send it to the PCO support (see **A4.4**).



Logging

Enable Logging: Activates Camware log files (cuts down camera's performance)

Clear Logfiles (only visible if logging is enabled): this command erases all actual log files

Explore Logfiles: opens windows explorer. Logfiles are formatted as e.g. SC2_Cam.log

Disable Logging (only visible if logging is enabled): disables logging



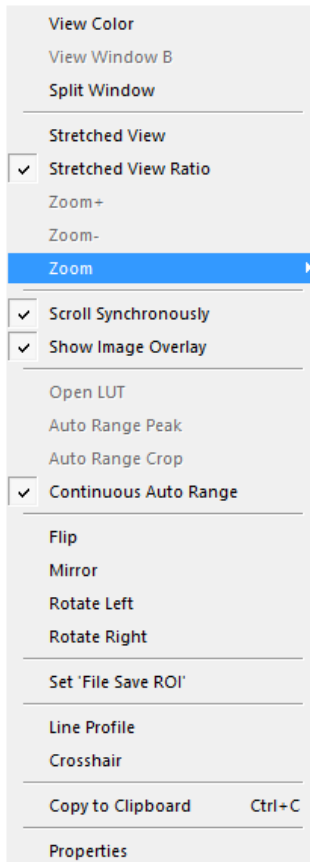
Support Mail

Opens your email-program and the created support file will be added automatically as file attachment.

About Camware

This window shows program version information.

6.9.8 VIEW WINDOW MENU

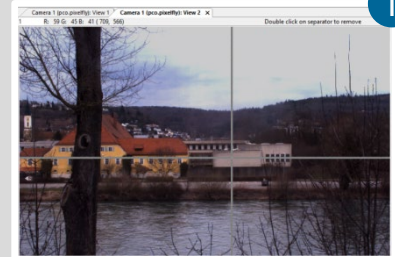


All functions of the **View window menu** are explained briefly. Right-click in the View window to open this menu.

View Color: color window.

View Window B: if Double Shutter mode is activated, this will switch to window B (second image).

Split window: ① splits the View window in four parts. Double click on separator to undo.



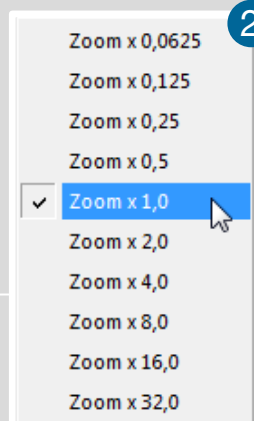
Stretched View: image will be fitted into the display window.

Stretched View Ratio: aspect ratio is maintained.

Zoom +/-: ② image zoom (only available if **Stretched View** is deactivated).

Zoom: set the Zoom factor (from 0.0625 to 32).

Scroll Synchronously: scroll synchronously through all open image windows (only available if **Stretched View** is deactivated).



Show Image Overlay: activates the overlay see 6.4

Open LUT: opens **look-up table** file for false-color assignment.

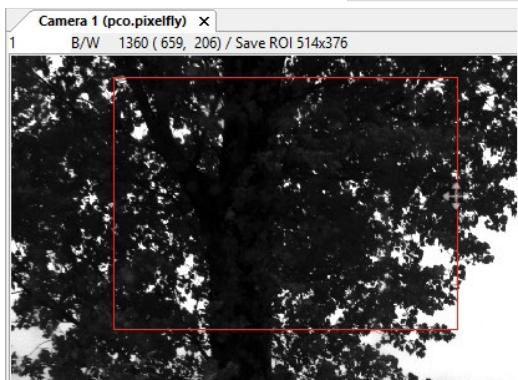
Auto Range Peak: searches for the minimum and maximum 14 bit intensity values of the image. Given these numbers the converter scales the 8 bit display (256) within these two values.

Auto Range Crop: sets the converter to ignore the extreme intensity values of the image and scales the display in a smaller range. Thus dark or bright light spots, reflections, etc. are cut off.

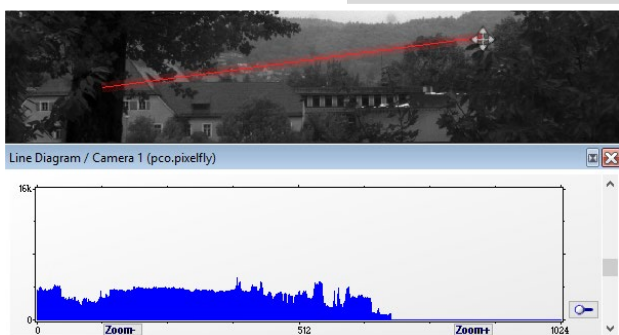
Continuous Auto Range (Crop): enables the automatic min / max function (Auto Range Crop) during record and replay.

Flip/Mirror: image will be flipped or mirrored.

Rotate Left/Right: rotates the image (each click 90°).



Set 'File Save ROI': to save just a part of the recorded image (region of interest), to draw a rectangle with the mouse. This rectangle is valid for all recorded images and can be dragged at its edges.



Line Tool: point the mouse where the line should start and left-click. Move the mouse to the desired line end and left click again. The line may be stretched, shrunk or moved by grasping its end point. A Line Diagram opens. The graph in the length of the line (units: pixel) is displayed showing the intensity values of the pixels along the red line.



Crosshair: activates a centered crosshair. Size and color are selectable see chapter 6.9.2 → **Options**. To move the Crosshair drag it by mouse. Reset it to center position by double-click into the center of the crosshair.

View Mode	
View Color	no
View Mode	Stretched View ...
Zoom	0.5
Common View Mode	
Flip	no
Mirror	no
Rotation	no
Scroll Synch...	yes
Show Image...	no
Image Conversion	
Convert Min	183
Convert Max	220

Copy to Clipboard: will copy the actual image to clipboard.

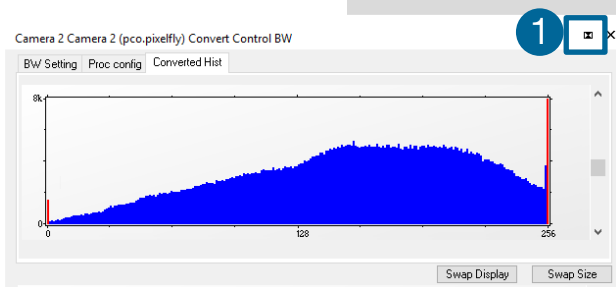
Properties: shows the current settings for **View Mode** / **Common View Mode** and **Image Conversion**.

6.9.9 ADDITIONAL FEATURES

White Balance by Mouse

Change **white balance** by mouse: Press CTRL (STRG) and shift button simultaneously and select a white or gray area within the image by dragging a rectangle while holding the left mouse button. The pixel values within the coordinates of the selection rectangle are used for calculating a new **white balance**.

For best results we recommend to use the white balance button in the Convert Control Color (see 6.3.6).



Fold Up Window

The Convert Control windows can be minimized / folded. ① Move the pointer over the bar and the window will unfold again ②.



Setting Contrast Area by Mouse

Control the minimum and maximum values used for the conversion from 14 bit to 8 bit with the mouse. Move the mouse cursor into a region which should be shown with maximum contrast. Press the shift and the left mouse button. Hold down the mouse button while changing the selection rectangle's size by moving the mouse. After releasing the mouse button the coordinates of the selection rectangle act as a border for calculating the minimum and maximum values.

Short Cut List

- Start / Stop record: ENTER
- Acquire Picture: SPACE (Soft Trigger mode)
- Acquire Sequence: STRG + A
- Auto Save: ALT + D
- Export File: STRG + T
- Export Recorder Sequence: STRG + O
- Open Raw Image File: STRG + I
- Open Raw Recorder Sequence: STRG + R
- Save Raw Image File: STRG + E
- Save Raw Recorder Sequence: STRG + S

APPENDIX

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A1 TECHNICAL DATA

A1.1 DATA SHEET

image sensor	
type of sensor	CCD
image sensor	ICX 285 AL (b/w); ICX 285AQ (color)
resolution (h x v)	1392 x 1040 pixel (normal) 800 x 600 (centered)
pixel size (h x v)	6.45 μm x 6.45 μm
sensor format / diagonal	2/3" / 11.14mm
shutter mode	global (snapshot)
MTF	77.5 lp/mm (theoretical)
fullwell capacity	16000 e ⁻ 24000 e ⁻ (binning)
readout noise	5 - 7 e ⁻ rms @ 12 MHz (typ) 6 - 8 e ⁻ rms @ 24 MHz (typ)
dynamic range	2667 : 1 (68 dB) 4000 : 1 (72 dB binning)
quantum efficiency	62% @ peak
spectral range	290 nm .. 1100 nm
dark current	1 e ⁻ /pixel/s @23°C
DSNU	2 e ⁻ rms
PRNU	< 1%

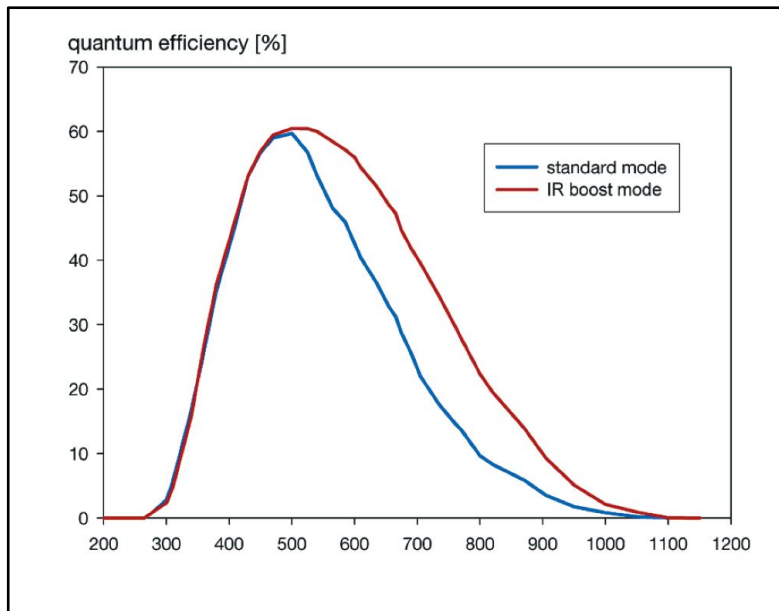
camera	
frame rate	7.3 / 13.5 fps (12 / 24 MHz normal) 11.7 / 21.6 fps (12 / 24 MHz centered)
exposure / shutter time	1 μs .. 60 s
dynamic range A/D	14 bit
A/D conversion factor	1.0 e ⁻ / count 1.5 e ⁻ / count
pixel scan rate	12 / 24 MHz
pixel data rate	19.5 Mpixel/s
binning (h x v)	1x1 .. 4x4
non linearity	< 1 %
smear	< 0.002 %
anti-blooming factor	> 400 (standard 100 ms exposure) > 4 (NIR boost 100 ms exposure)
interframing time	1 μs (optional)
trigger input signals	software / TTL level
trigger output signals	3.3 V LVTTTL level
data interface	USB 2.0

general	
power supply	9 .. 28 VAC (12 VDC optional)
power consumption	< 4 W
weight	0.25 kg
operating temperature	+10°C .. +45°C
operating humidity range	10% .. 80% (non-condensing)
storing temperature range	-20°C .. +70°C
optical interface	C-mount
CE / FCC certified	yes

Subject to change, please refer to current data sheet available on our website.

A1.2 QE CURVE

QE curve monochrome sensor version.
QE curve of the color version on request.



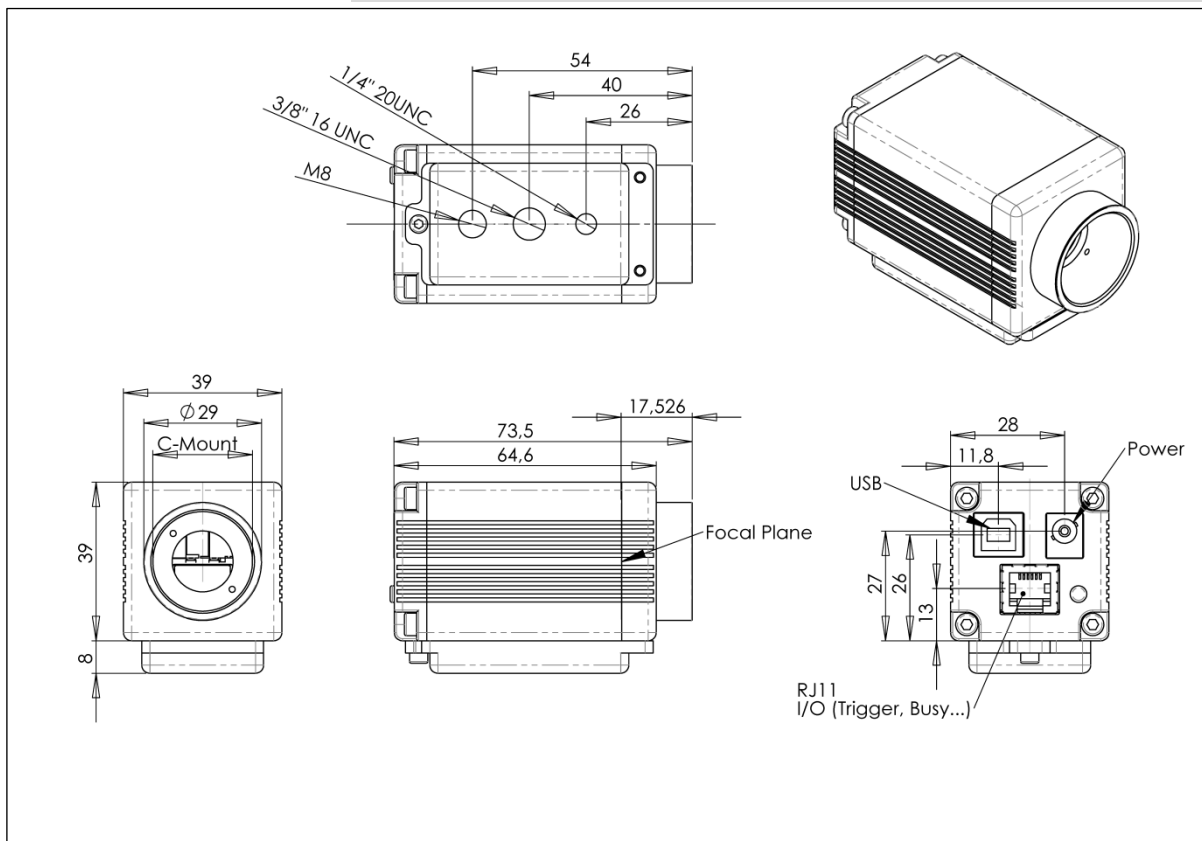
A1.3 TRIGGER INTERFACE



Connect the trigger interface to the RJ11-Connector of your camera. It is equipped with three BNC sockets (Trigger / Busy / Exposure). The trigger interface is **just a connection adapter** from RJ 11 to BNC without any active electronics.

For more information regarding trigger modes see **A1.4** and **6.3.1**.

A1.4 MECHANICAL DIMENSIONS

**NOTE**

C-Mount flange focal distance: 17,52 mm

All dimensions given in millimeter.

A1.5 INPUT WINDOW FILTER

B/w version: the input window of the pco.pixelfly usb camera contains a 300 nm – 800 nm anti-reflex coating (98 % light transmission).

Color version: the input window of the pco.pixelfly color usb camera contains an IR cut-off filter.

Visible transmission: > 90 % @ 425 nm – 680 nm

IR transmission: < 3 % @ 800 nm – 1150 nm

A1.6 REAR PANEL

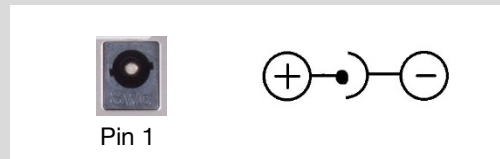


USB 2.0 plug ①

Power socket ②:
Input: 10...28V; max. 4W

RJ 11 connector ③

LED indicates status ④

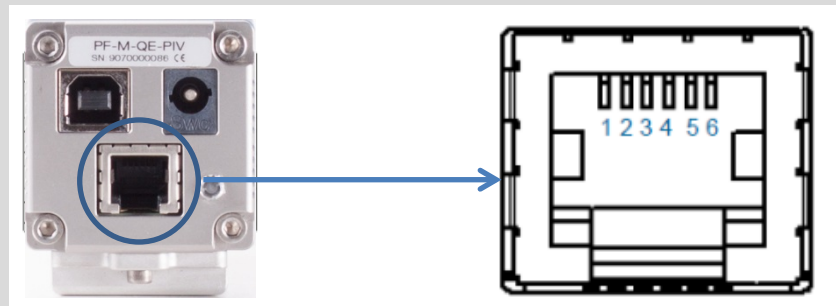


Color	Description	
Green continuous	camera is ready	●
Green blinking	camera is in record state	●
Red continuous	error	●
Red blinking	boot loader	●
Red / green blinking	firmware update	●●

Pinout of RJ11 connector

Pin	Description
1	Ground
2	Exposure out (3V)
3	Busy out (3V)
4	Acquire in (not used)
5	Trigger in (TTL 0...5V)
6	+12V (alternative power supply)

Pin Position



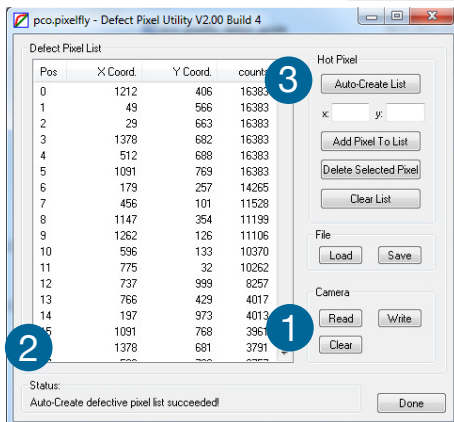
Timing & Signals

busy = TRUE:	camera is recording or sensor readout in progress
busy = FALSE:	external trigger is ready to accept
exposure = TRUE:	exposure of image sensor

In **Auto Sequence** trigger mode the busy signal is always set to TRUE, while the exposure signal indicates the real exposure of the image sensor.

In **External Exp. Start** trigger mode the camera is ready to accept a new trigger signal on **PIN #5 (trigger)** when the busy signal is set to FALSE. After a successful trigger event the busy signal stays TRUE until the exposure is finished and the image is completely read out.

A2 HOT PIXEL UTILITY



From time to time it makes sense to check the camera for new hot pixels. After long operating times, due to physical processes, further hot / defective pixel may occur.

Therefore PCO created the program **Pixelfly_DEFPIX.exe**. It can be used to **create or edit** the **hot/defective pixel list** of a pco.pixelfly usb with hot/defective pixel option enabled (firmware 1.0.28 or higher).

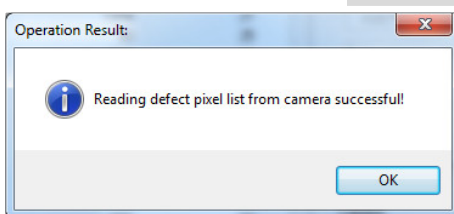
Choose either: Auto-create a new list of defective pixels or edit an existing one.

Auto create list of hot/ defective pixels

After start-up of the program the dialog on the left is shown (this can take a few seconds):

The **Defective Pixel Utility** tries to initialize a possibly connected camera. In case a camera is connected the **Read**, **Write** and **Clear** button **1** inside the camera group will be enabled.

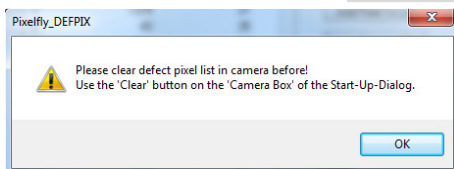
Additionally the **Status** **2** will show the camera type and its serial number.



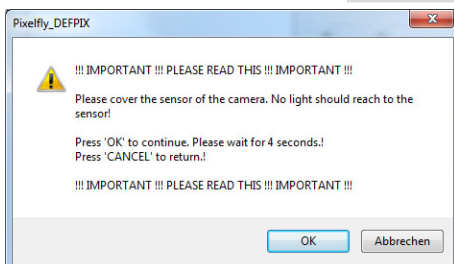
In order to simplify the creation of a new list use the **Auto Create List** **3** button. Firstly the current list is read from the camera

NOTE:

Close Camware before using the defective pixel utility.



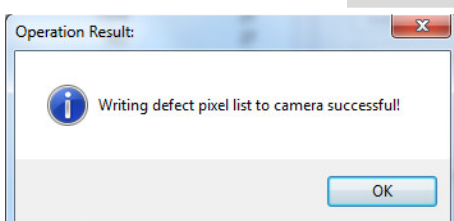
Only if the list is empty the Auto-Create-List process can continue. If the camera contains a list of defective pixel the program will return to the start-up dialog. In this case use the **Clear** button **1** of the **Camera Box** to delete the current list of defective pixel from the camera.



If the camera doesn't contain a list of defective pixel the program will return to the Start-Up dialog.

Please cover the sensor with the supplied c-mount protection cap! It's not enough just to place lens cap!

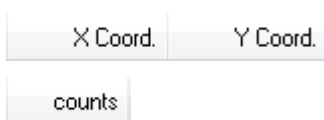
Press OK to continue. An image with an exposure time of four seconds will be recorded. Please wait for about four seconds till the image is recorded successfully. After that a list of defective pixels is created using the recorded image. The process ends with the message box.



At last the list of defective pixels is automatically written to the camera. The list is sorted by ascending **hot pixel counts** order.

NOTE:

The default list of defective pixels always has 220 entries. This **doesn't** mean that your camera has 220 hot or defective pixels!



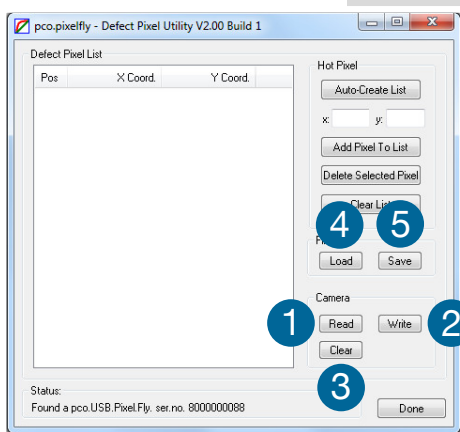
Press the x Coord. bar or the y Coord. bar to sort the list according to ascending y-coordinate order.

Press the counts-column bar to sort the list according to ascending counts order.

NOTE:

Saved to your camera are only x- and y-coordinates – counts are only shown on your screen and will not be saved.

Edit existing list of defective pixels

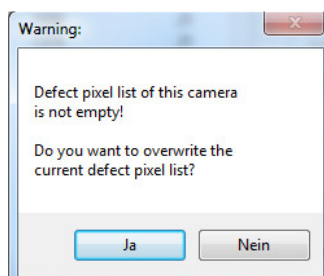


Camera Box:

After reading the list from the camera using the **Read** button ① of the Camera Box the user can edit the list and write the list back to the camera using the **Write** button ② of the Camera Box.

A message box will appear warning that an already existing list of defective pixels is going to be overwritten inside the camera.

Select **Yes** to write the new list into the camera flash. The new list will be activated after the next power-up. Use the **Clear** ③ button to delete an existing list of defective pixels flashed to the camera.



File Box:

Additionally there is a possibility to save and load files in the DPX format using the **Save** ⑤ and **Load** ④ buttons. DPX is a proprietary file format of pco. The files created can be edited with every text editor, since the content is plain ASCII.

The content of the DPX file is as follows, e.g.:

```
pco.camera defective pixel list V01.00
200;200
220;208
300;409

<header><CRLF>
[x1;y1<CRLF>
...
xn;yn]
...
```

The header is mandatory in order to recognize a DPX file. Each line after the header will be treated as a x/y coordinate pair, starting with x followed by y. Each new line has to be separated by a CRLF.

NOTE

If you want to add a new hot pixel to the list, you should recreate the whole list. In case the intended hot pixel is not listed, delete one of those 220 hot pixels from the list, which is not critical for you. Then you can add the critical one. If there is no space for a new hot pixel, the pixel with the highest y-coordinate will be overwritten automatically.

A3 IMAGE FILE FORMATS

There are different file formats available for saving camera images with Camware.

b16

The b16 16 bit format is similar to the bmp format. However, 16 bit pixel values are used instead of 8 bit pixel values.

The file format consists either of a Basic Header (6 Long-parameter) or an Extended Header (32 Long-parameter), the latter of which is optional for additional information. It might follow a variable comment field (ASCII code). Finally, there is the actual data set that is saved linearly (as in the case of BMP files).

With the exception of the first value, all parameters are Long Integers (4 Byte). The first 6 parameters must always exist. The rest of the parameters, as well as the comment field, are optional.

	Parameter	Function
1	PCO-	the first 4 byte are the characters PCO-
2	file size	file size in byte
3	header length	header size + comment field in byte
4	image width	image width in pixel
5	image height	image height in pixel
6	extended header	-1 (true), extended header follows
7	color mode	0 = black/white camera, 1 = color camera
8	b/w min	black/white LUT-setting, minimum value
9	b/w max	black/white LUT-setting, maximum value
10	b/w linlog	black/white LUT-setting, 0 = linear, 1 = logarithmic
11	red min	red LUT-setting, minimum value
12	red max	red LUT-setting, maximum value
13	green min	green LUT-setting, minimum value
14	green max	green LUT-setting, maximum value
15	blue min	blue LUT-setting, minimum value
16	blue max	blue LUT-setting, maximum value
17	color linlog	color LUT-setting, 0 = linear, 1 = logarithmic
18	internal use	
...		
266		
Comment file in ASCII characters with variable length of 0...XX. The length of the comment file must be documented in the header length field.		
16 bit pixel data		
line 1, pixel 1	value of the first pixel	
line 1, pixel 2	value of the second pixel	
...	...	

We recommend that all images should be saved first in the b16 or TIFF format. The advantage is to have the b16 or tiff images available all the time. You will always have the maximum 16 bit information. Note that not all image analysis programs can accommodate 16 bit data. The 8 bit format saves only the information displayed on the monitor screen. The 16 bit information will be lost and cannot be recovered.

pcoraw

This 16 bit PCO file format is based on the new BigTIFF format, thus allowing for file size > 4GB. A new PCO proprietary compression scheme is added in case it is necessary

Standard File Formats

TIFF

Tag Image File Format, version 6.0 and lower. There is a 16bit monochrome and color image format.

BMP

Windows Bitmap Format, b/w or color 8 bit format-images, which have been saved in BMP format can be loaded later only as 8 bit images, i.e. part of the original information (16 bit) is lost.

FTS

Flexible Image Transport System, Version 3.1 is a 16 bit image format. The NASA/Science Office of Standards and Technology (NOST) defined it. Some programs use the FIT extension for this format.

ASCII

16 bit format, some mathematical programs prefer ASCII data.

JPG

JPEG (named after the Joint Photographic Experts Group who created the standard) is a commonly used method of lossy compression for photographic images. The degree of compression can be adjusted, allowing a selectable tradeoff between storage size and image quality.

JP2

JPEG 2000 is a wavelet-based image compression standard and coding system. It was created by the Joint Photographic Experts Group committee in the year 2000 with the intention of superseding their original discrete cosine transform-based JPEG standard (created 1992).

AVI

Audio Video Interleave is a multimedia container format introduced by Microsoft in November 1992 as part of its Video for Windows technology.

MPG

MPEG-1, similar to JPEG, is a standard for lossy compression of video and audio developed by the Moving Picture Experts Group (MPEG).

WMV

Windows Media Video (WMV) is a compressed video compression format for several proprietary codecs developed by Microsoft. The original video format, known as WMV, was originally designed for Internet streaming applications, as a competitor to RealVideo.

A4 CUSTOMER SERVICE

A4.1 SERVICE

The camera is designed to operate with no need of special adjustments or periodic inspections.

A4.2 MAINTENANCE



CAUTION

UNPLUG CAMERA BEFORE CLEANING

Risk of injury due to electric shock!

- Unplug the camera from any power supply before cleaning it.

NOTICE

CLEANING

- Use a soft, dry cloth for cleaning the camera.
- Do not clean the input window unless it is absolutely necessary (clean it with pressurized air).
- Be careful and avoid scratches and damage to the input window surface.
- Do not use liquid cleaners or sprays.

NOTICE

LENS CLEANING

- The lens is best cleaned with pressurized air or with liquid cleaners such as pure alcohol or with special optical cleaners are available at high quality photo stores.
- Use a cotton swab dipped in pure alcohol or optical cleaning liquid and wipe only on the glass surface.
- Do not get any cleaning liquid on the metallic parts such as the lens thread, because tiny detached particles may scratch the surface.

NOTICE

CLEANING LIQUIDS

Aggressive cleaning liquids can damage your camera.

- Never use aggressive cleaning liquids such as gasoline, acetone, spirits or nitro cleanser.
- Every time the input window is cleaned, there is the possibility of surface damage.

NOTICE

PROTECTIVE CAP

Always store the camera with the protective cap or with a lens mounted to avoid dust and dirt on the input window.

A4.3 RECYCLING



To dispose your camera, please **send it to PCO** or take it to a local **recycling center**.

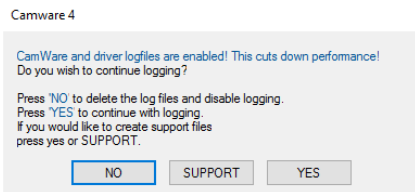
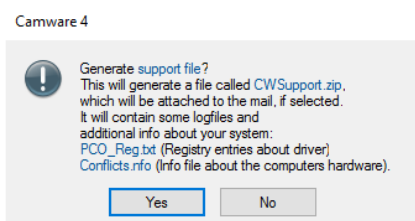
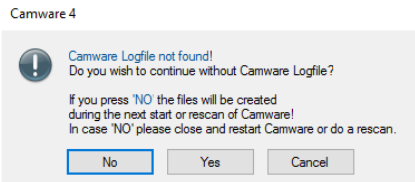
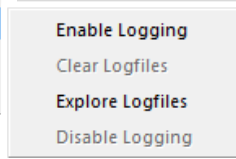
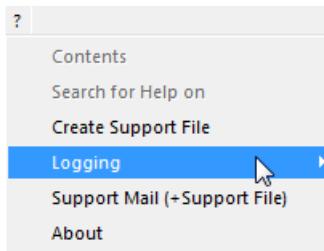
The camera includes electronic devices, which can contain materials harmful to the environment. These electronic devices must be recycled.

A4.4 TROUBLE SHOOTING

If you have a question, which is not adequately addressed in this manual, please contact **PCO** or your **local dealer**.

To speed your request, we need the following information:

Short description of the problem	Operating system (PC)
Description of your application	Processor type (PC)
Camera settings	Memory
Type and version of camera	Graphic card
Software being used	Graphic card setup
Camera serial number	



How to create a logfile:

Enable log files:	? Help Menu → Logging → Enable Logfile → Camware will ask you to press NO to activate Logfiles after restart of Camware
Repeat	the workflow which produces the faults
Open the Help Menu	Click Support Mail (+ Support File) → Camware will ask you: Generate support file?
Save this file	(CWSupport.zip – don't rename it) and send it to PCO Support (support@pco.de)
Or visit our website:	http://www.pco.de/support/ and upload the support file with our support form

Repair

Before sending the camera for **repair**, **first contact** your local dealer or **PCO** respectively.

When shipping the camera for repair, be certain to carefully pack the camera with proper shipping materials. If possible use the original packaging. Use the protection cap to protect the camera on the lens thread.

Firmware, Software and Driver Update

You will find all necessary software and drivers on the accompanying USB storage device.

For the latest versions please check our [Website](http://www.pco.de/support/).

A5 INDEX

NOTE:

The mentioned page is always the starting page of a chapter!

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ABOUT PCO



pco.

In 1987, PCO was founded with the objective to develop and to produce specialized, fast and sensitive video camera systems, mainly for scientific applications. Meanwhile the product range of PCO cameras covers digital camera systems with high dynamic range, high resolution, high speed and low noise, which are sold in the scientific and industrial market all over the world.

Currently PCO is one of the leading manufacturers of scientific cameras. Worldwide representatives, together with our own sales department and technical support assure that we keep in touch with our customers and their needs. The actual wide range of specialized camera systems is the result of technical challenge and product specific know-how. A design according to advanced techniques, a high standard of production and strict quality controls guarantee a reliable operation of the cameras. Our own developments in conjunction with an excellent contact to leading manufacturers of image sensors ensure our access to state-of-the-art CCD- and CMOS-technology for our cameras.

Since 2001, PCO is located in its own facility building in Kelheim at the shore of the beautiful and international river Danube. Here in the county Bavaria, which is well known for its excellent support and conditions for high technology companies, we share the benefits of the simple access to high performance products and services in the surrounding area.

Kelheim itself is a historical town, first documented in 866. The small city is founded at the confluence of the Danube and the Altmühl, which has been converted into the Rhine-Main-Danube bypass channel for water transport. Located in Danube-valley, it is the heart of a beautiful river and forest covered lime plateau landscape. It's landmark, the Hall of Liberation, was built by Ludwig I. in 1863 on the Mount Michael and is visible from all over the city and valley. The beautiful Danube-Gorge, which is protected as natural monument since 1840, is located between Kelheim and the famous abbey Weltenburg.

pcó.