user manual

pco.ultraviolet

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

Contact us for further questions or comments.

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The cover picture shows a typical pco.ultraviolet camera system.
The lens is sold separately.

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pco.ultraviolet User Manual V2.13 © PCO AG, Germany

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1. INTRODUCTION

Advantages of the pco.ultraviolet

Features

This high performance 14 bit CCD camera system has an extraordinary quantum efficiency of up to 40% at a wavelength of 193nm. This sensitivity is true sensor performance, without any additional coating. At the heart of the camera is a FPGA processor allowing for sophisticated control and accurate timing of the CCD and associated electronics. In addition, a proprietary offset control algorithm has been developed which provides 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:

- *excellent resolution* of 1392 x 1040 pixel
- *superior UV sensitivity* of up to 40% QE @ 193nm
- superior *low noise* of 7 … 9 e- rms
- *14 bit* dynamic range: 1750:1 (65dB), 3000:1 (69,5dB) binning
- *excellent DSNU* at long exposure times
- *outstanding offset stability* and control (< 1 count)
- *hot pixel correction* integrated
- *USB 2.0* 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

- UV detection
- powerline control
- hyperspectral imaging
- wafer inspection
- mask inspection
- scientific imaging
- material testing
- industrial applications

- low light level imaging
- corona discharge
- combustion imaging
- high resolution microscopy
- machine vision
- spectroscopy
- luminescence spectroscopy
- industrial OEM applications

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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, DUST 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 levels of x-ray radiation.

NOTICE

SHOCK & VIBRATION
To prevent damage to the camera, the system must be kept stable and protected against strong jolts or vibrations.
➔ Use the mounting threads of the camera to mount the camera stable.

NOTICE

LENS MOUNTING
Do not force the lens onto the camera.
➔ To protect the lens connector thread from damage, use minimal force when attaching a lens to the camera.

NOTICE

LIQUIDS DAMAGE CAMERA
If liquids have penetrated the device.
➔ Immediately switch off the camera, separate it from power line and contact our customer support.

NOTICE

DAMAGED CAMERA HOUSING
If the camera has been dropped or the casing is damaged.
➔ Immediately switch off the camera, separate it from power line and contact our customer support.

NOTICE

IF CAMERA IS NOT WORKING PROPERLY
If, after thoroughly reviewing the instruction manual, the device is still not operating properly.
➔ Immediately switch off the camera, separate it from power line and contact our customer support.

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3. SYSTEM COMPONENTS
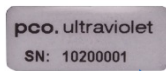
The camera system includes the following parts.

Camera

C-mount optical connection:
The distance between the front edge of the c-mount and the sensor is 17.52 mm. The standard for 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)

Serial Number Tag

Mounting Thread
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++

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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. ❶
After finishing ❷ 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 a computer, Windows will notify the user that a new device has been detected.
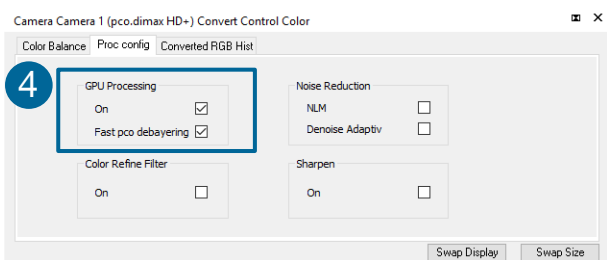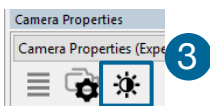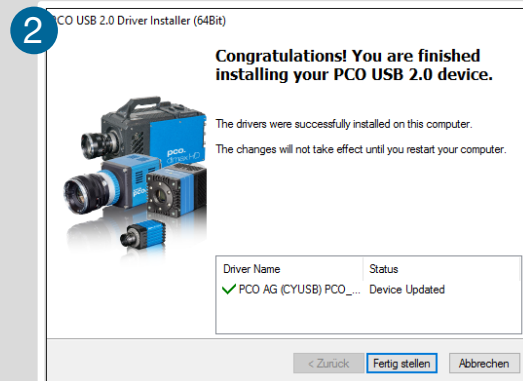
NVIDIA Cuda Driver:

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*** ❹ in the ***Convert Control window*** ❸ (see Convert Control chapter **6.3.7**).
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.

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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 for Camera Link Interface (not recommended for pco.ultraviolet)

④ After the next two screens installation is complete

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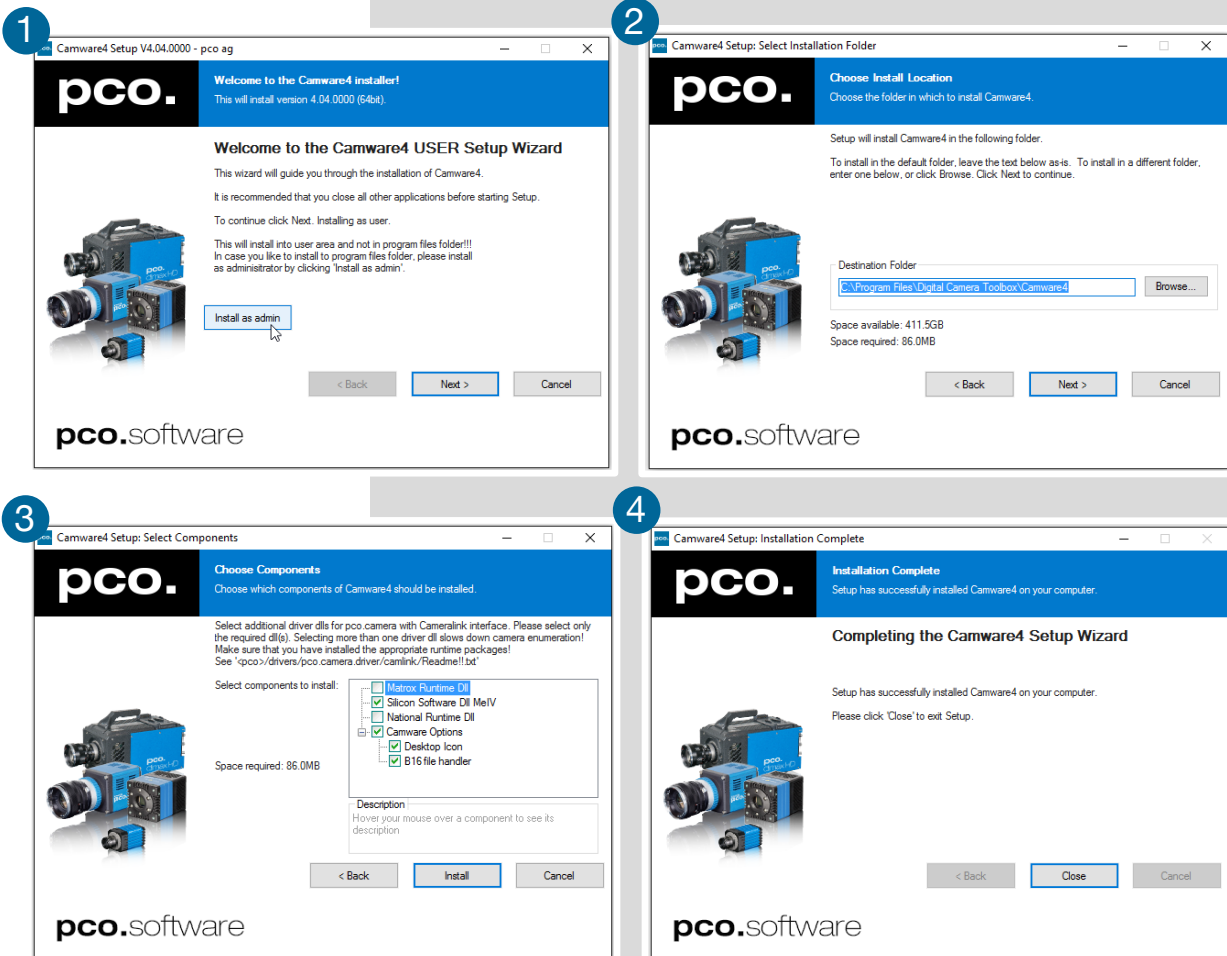
5. QUICK START

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

5.2 START

Start ***Camware*** and the ***graphical user interface*** will start up:
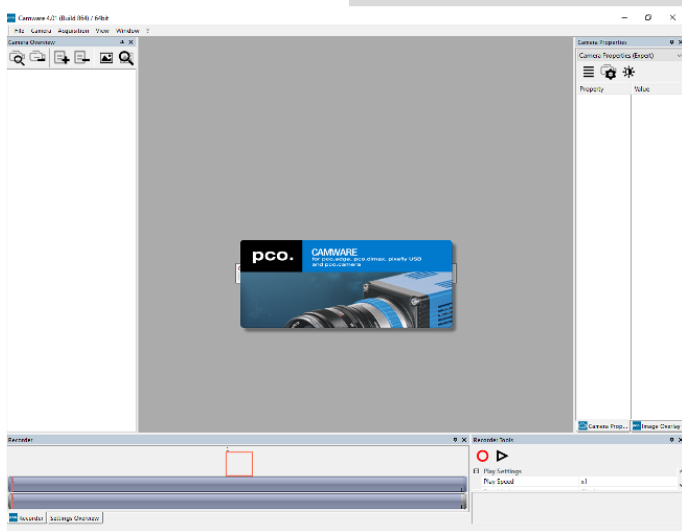
NOTE
Always install latest Camware version to be able to use full functionality of your pco camera (www.pco.de/support).

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5.3 FIRST IMAGE
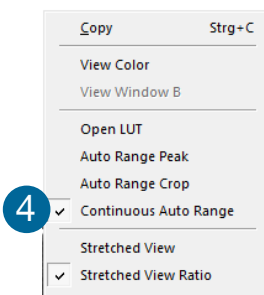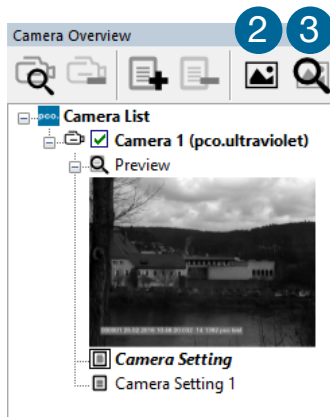
Please follow the instructions:

- *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
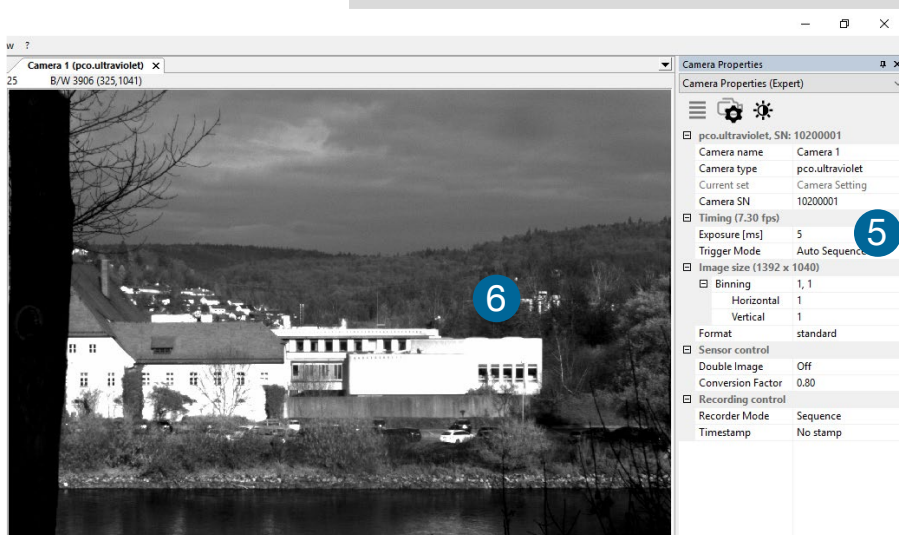
If you need to change *exposure* time (e.g. the image is still either too dark or too bright), please go to chapter **6.3.1**.

For recording and saving images, please see chapter **6.3.4** and chapter **6.7** for detailed information.

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

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6. CAMWARE 4 SOFTWARE

PCO's Camware is an 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

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

6.3.1 Timing	Exposure time / Trigger modes
6.3.2 Image Size	Sensor format / Binning
6.3.3 Sensor Control	Double Shutter / Conversion factor
6.3.4 Recording Control	Recorder mode / Timestamp
6.3.5 Status	Electronics temperature
6.3.6 Convert Control Dialog	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 Dialog

Chapter 6.9 describes the tabs (File, Camera Acquisation, View, Window, Help) 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…
6.9.9 Additional features	White Balance / Contrast / Short cut list

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6.2 CAMERA OVERVIEW / LIST
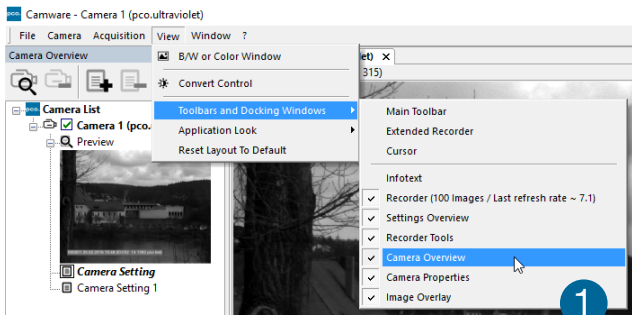
If closed, the **Camera Overview** window can be opened by selecting the **View** tab and **Toolbars and Docking Windows** → **Camera Overview**. ❶
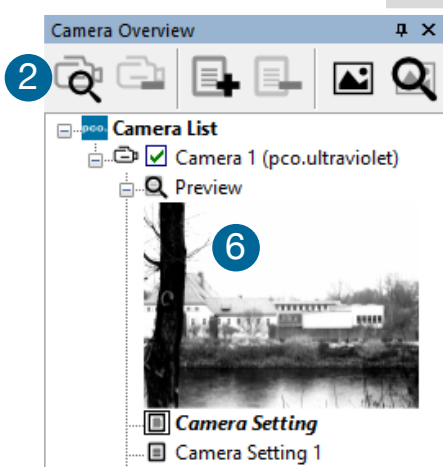
The **Camera Overview** window allows you to manage several connected cameras. It displays a list of all connected PCO cameras. Camware is able to **scan** ❷ for connected cameras or close a connected camera. It is possible to define several different **Settings** for each camera (max. 30 sets per camera → **add new set** ❸).
**New view windows** ❹ can be opened and the **Live Preview** ❺ function can be started. When unfolded the **Preview** shows a **small preview window** ❻ (always monochrome) integrated to 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 presettings, 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 copied to other cameras.
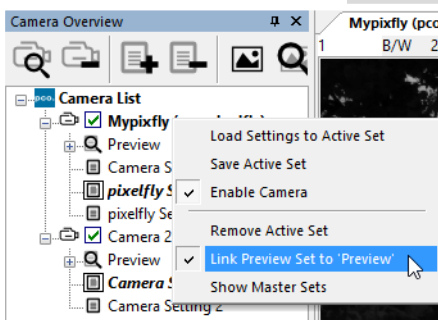
Link Preview Set to 'Preview'
With **Link Preview Set to Preview** activated, the Preview set with its parameters always active when starting a **Live Preview** ❺.
In case this function is deactivated the **Live Preview** always shows live images with the parameters of your active setting.
This feature is beneficial if preview light conditions are different from those in recording situations.

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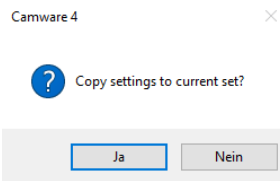
Click and drag camera setting: If you want to copy e.g. *Camera Setting 1* to *Camera Setting 4*, just drag *Setting 1* to *Setting 4* and Camware will ask you if you want to copy the settings. It is possible to copy each setting to every camera.

Master Sets

This function facilitates image acqusition 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*.
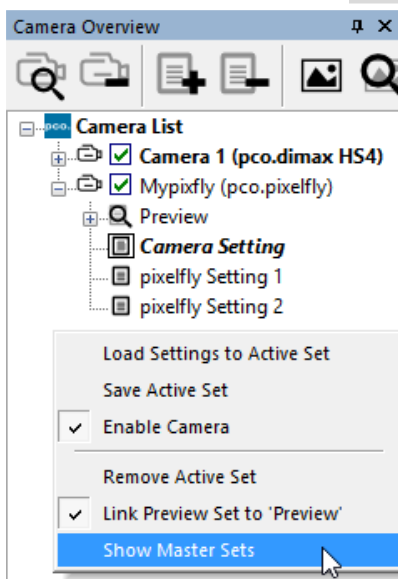
To display Master Sets, please right-click in the *Camera Overview* window and select *Show Master Sets*.
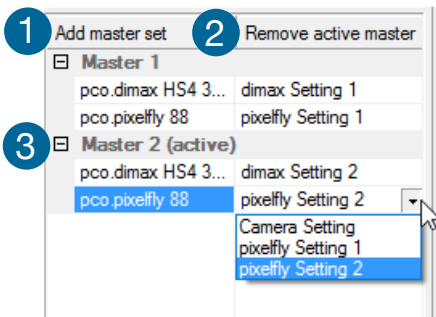
Master Set window
Define different Master Sets. Select individual *Camera Settings* within each *Master Set*.

Functions:
Add *Master Set* ❶ or *Remove active master* ❷.
Activate it by clicking on one set ❸.

Important Setting (for cameras without internal memory)
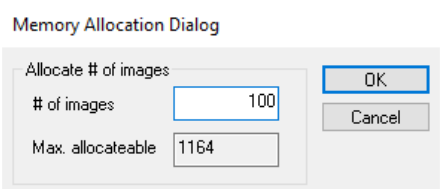
Memory Allocation Dialog
To change the *number of recorded images* in Camware, open the *Acquisition Tab (see 6.7.4)* and choose *Recorder Memory Settings*.
It sets the number of images recorded in one sequence. The maximum is defined by approved RAM size.

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 **Convert Control** (see **6.3.5**) can be opened additionally.

Three view options with various functions can be selected: **Basic**, **Custom** and **Expert**.
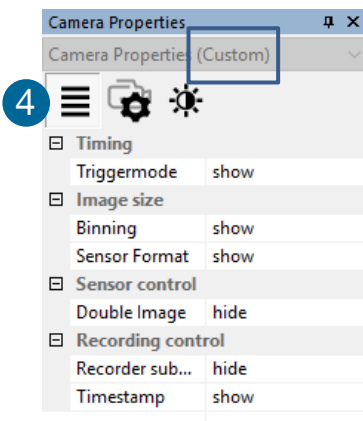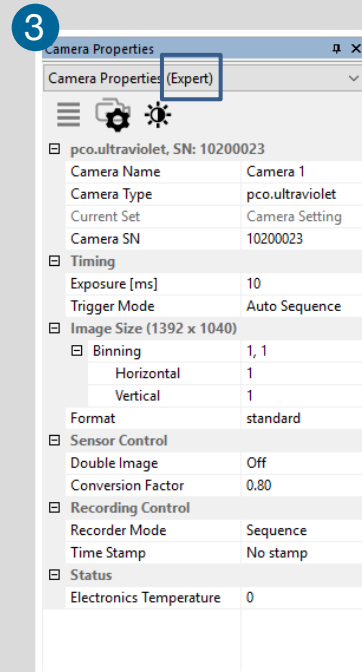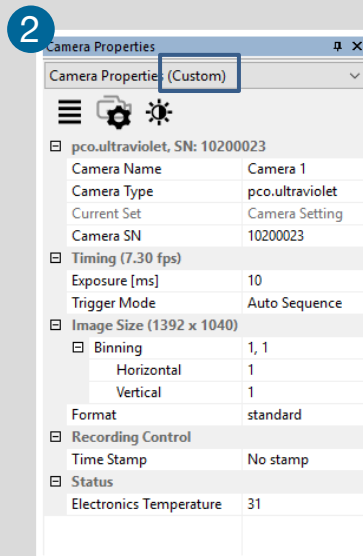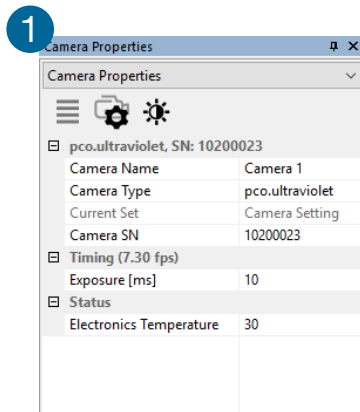
Basic mode ❶ only shows camera name, type, settings, serial number and the exposure time. In **Basic Mode** the frame rate is always calculated automatically based on the selected exposure time, i.e. while exposure time is increased, frame rate decreases. It is recommended for Camware beginners.

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

Expert mode ❸ (for advanced users) shows all possible **Camera Property** settings.

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

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6.3.1 TIMING

Trigger Modes ❶

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

In the *Auto Sequence* mode, the camera achieves the fastest possible frame rate depending on the adjusted exposure time and the required readout time.

Upon a start command images are recorded until a stop command.

Software Trigger: single images are recorded by this Camware command. The single image is acquired by pressing the Single Trigger button. This button appears after pressing the Start Record button (see **6.4**). Other signals have no influence on this operating mode.
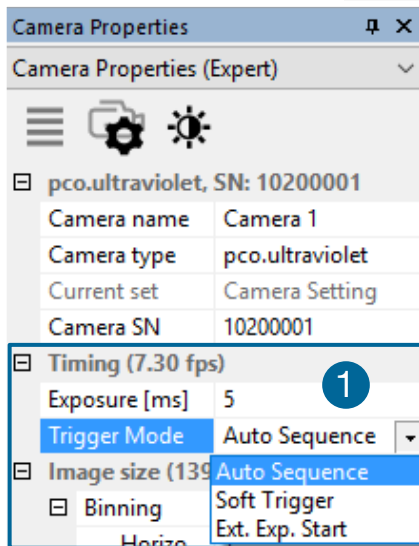
External Exposure Start: image acquisition is triggered by an external signal. The single trigger button acquires a single image for a test.

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 **A1.3, A2**).
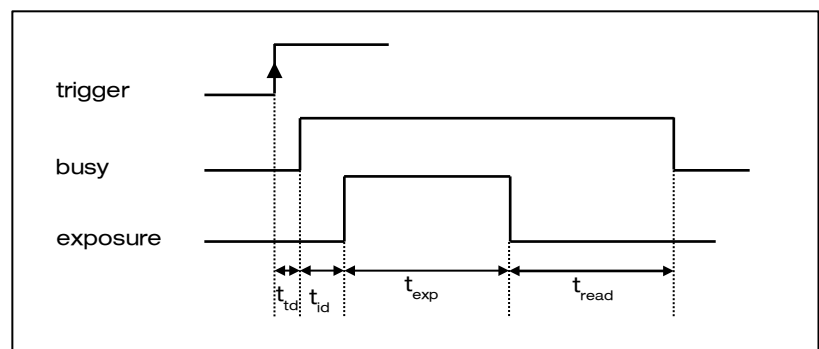
| t_{td} | trigger acknowledge delay | t_{id} | intrinsic delay |
| t_{read} | readout time | t_{exp} | exposure time |

pixel clock	intrinsic + trigger acknowledge delay
12 MHz	5.8 µs

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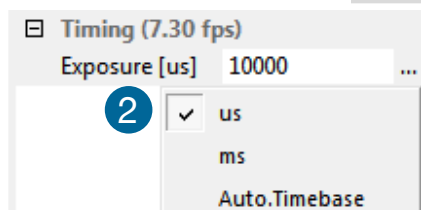
ITime-base may be changed from *automatic* to µs or ms. If your input is out of the range of the camera, it will be automatically changed to the nearest possible setting. The current frame rate (fps) is always displayed. The exposure time (delay time setting is not available for pco.ultraviolet) can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

camera type	exposure time
pco.ultraviolet	1 µs … 60 s

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6.3.2 IMAGE SIZE

Camera Properties	⫪ ✕
Camera Properties (Expert)	⌄

≡ ⚙ ☀

⊟ pco.ultraviolet, SN: 10200001

Camera name	Camera 1
Camera type	pco.ultraviolet
Current set	Camera Setting
Camera SN	10200001

⊟ Timing (27.03 fps)

Exposure [ms]	6
Trigger Mode	Auto Sequence

⊟ Image size (348 x 260) ①

⊟ Binning	4, 4
Horizo...	4 ②
Vertical	4
Format	standard ③
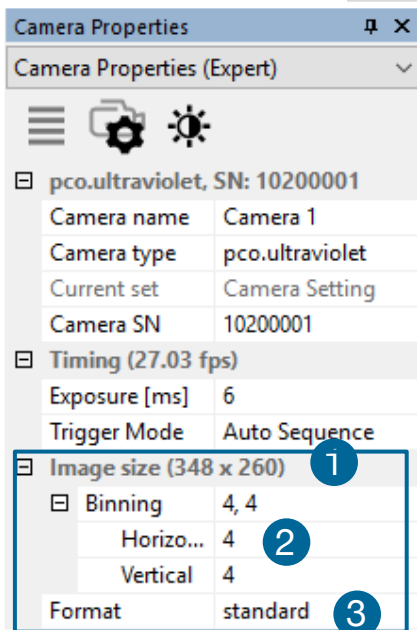
The actual image size ① is displayed here. **Binning** or **Region of Interest** settings affect the image size and are applied automatically.

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 increases 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 of 1392 x 1040 pixels (effective pixels recommended by the sensor manufacturer) or an alternative size of 800 x 600 pixel (center mode).
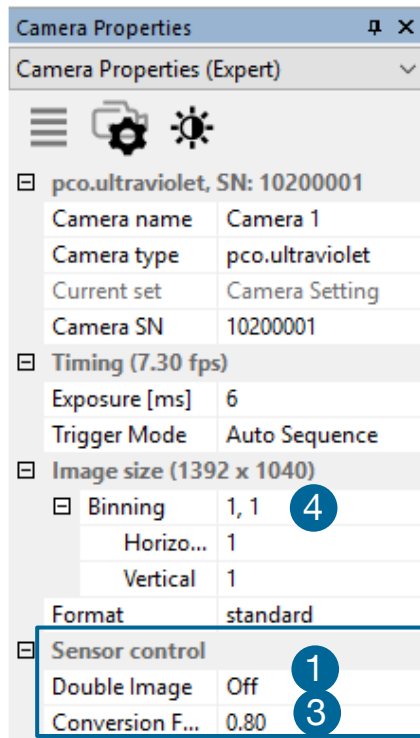
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6.3.3 SENSOR CONTROL

Sensor Control allows controlling of all sensor specific settings.

Double Image / Doubleshutter ❶

This feature is widely used for particle image velocimetry (PIV) measurements and is an standard feature of the pco.ultraviolet. The first exposure time t_{exp1} may be any exposure time of the available range of the pco.ultraviolet 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 **A1.3**.

	24 MHz
$t_{td} + t_{id}$	5.8 µs
t_{exp}	1 µs … 60 s
t_{read}	140 ms (@ full resolution)
t_{itf}	1 µs

While recording in Double Shutter mode, Camware will automatically **split the view window** ❷ and always shows both images side by side.
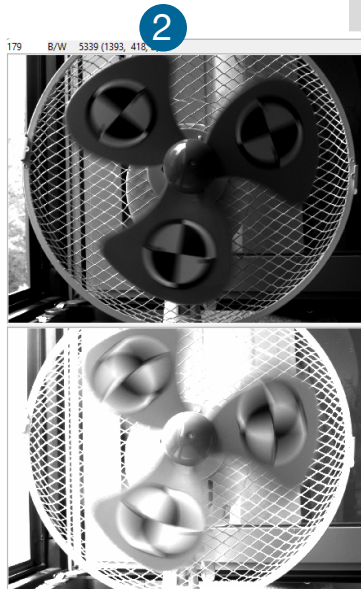
Double Shutter timing
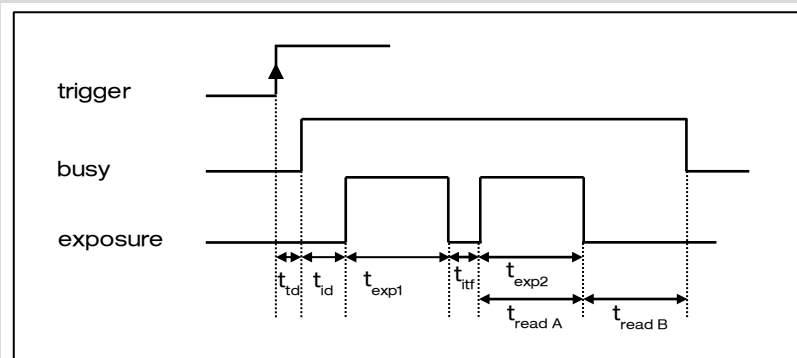
t_{td}: trigger acknowledge delay t_{id}: intrinsic delay
t_{exp1}: exposure time 1st image t_{readA}: readout time 1st image
t_{exp2}: exposure time 2nd image t_{readB}: readout time 2nd image
t_{itf}: interframing time

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Conversion Factor ❸

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.ultraviolet has two conversion factors namely 0.8 e⁻ and 1.4 e⁻ / count which both can be used in *1x1 (full resolution)* ❹ and higher binning modes. As mentioned in **6.3.2.** binning is available for the pco.ultraviolet. The usable extended fullwell-capacity rises in binning mode from 14000 to 24000e⁻. In *1x1 (full resolution)* it makes sense to keep 0.8 e⁻/count; changing the conversion factor to 1.4e⁻ the high dynamic of 16384 grey steps is not usable.. In higher *binning modes* you can use both conversion factors: Having a lowlight scene the 0.8 e⁻/count mode helps to spread the low image information content – in normal light scenes it makes sense to use 1.4e⁻/count for full dynamic availability.

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6.3.4 RECORDING CONTROL
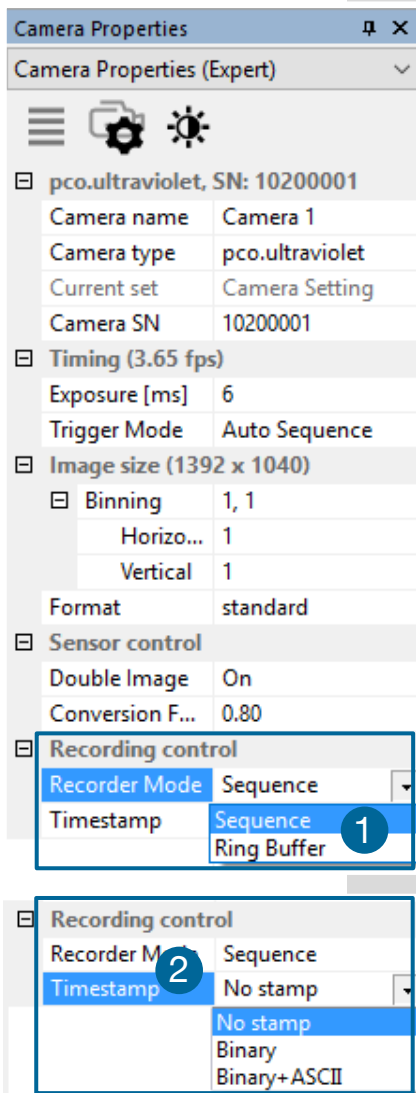
Recorder Mode ❶

In *Sequence* mode 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 ❷

A timestamp can be placed into the upper left corner of the image. It can be either *No stamp*, *Binary* or *Binary + ASCII*. The time resolution is 1 µs.

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 can hold 2 digits. If the pixels have more resolution than 8 bits, then the BCD digits are right bound adjusted 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).

Timestamp shows the *end* of exposure time.

Three different *information* is stamped onto the image: image number ❸ of the, date ❹ and time ❺.
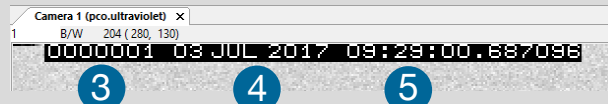
Additionally to *Timestamp* the *Image overlay* function is available, see chapter **6.4**.

6.3.5 STATUS

Shows the current temperature level of the pco.ultraviolet camera.

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6.3.6 CONVERT CONTROL DIALOG

Start the **Convert Control Dialog** with the **Black/White Button** in Camera Properties.
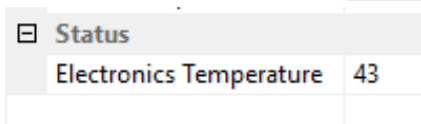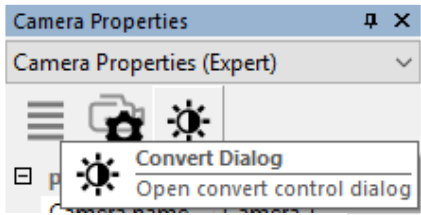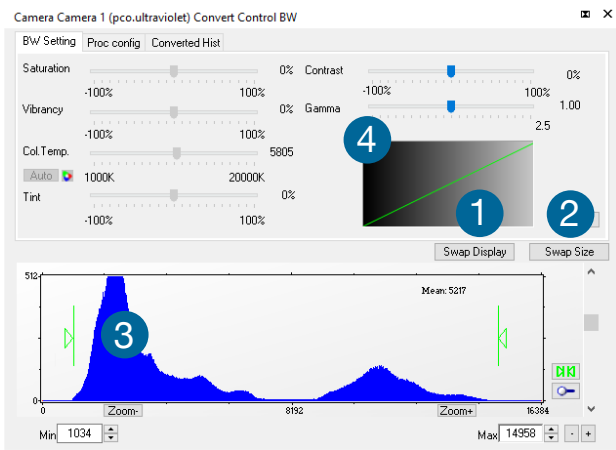
Convert Control BW
The user can manipulate the display of the original 14 bit image intensity values (x-axis) in the displayed 8 bit values (y-axis).

***BW Settings (includes histogram of original data)***

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

Green sliders in histogram ❸
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** ❹, reflects the calculation.
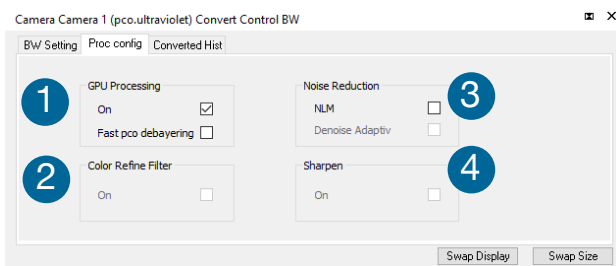
Proc. Config (Process configuration)
Due to proprietary high-end algorithms used for these image processing features, no detailed description is given here.

❶	**GPU Processing** **On:** Switch on in order to significantly reduce processing time (increases refresh rate of the live image. **Fast pco debayering:** not available
❷	**Color Refine Filter** not available
❸	**Noise Reduction** **NLM:** Non local means algorithm **Denoise Adaptive:** not available
❹	**Sharpen:** **On:** not available
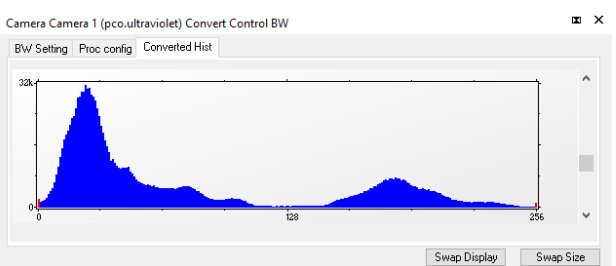
Converted Hist
This tab shows you the ***histogram of converted data.***

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

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6.4 IMAGE OVERLAY

Open **Image Overlay**: these two buttons allow easy switch between **Camera Properties** and **Image Overlay**. ❶
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...** ❷
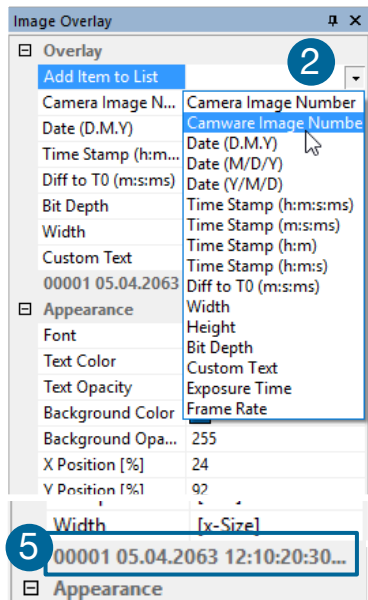
Also the **Appearance** is configurable:
Font, Text color, Text opacity, Background color, Background opacity and horizontal or vertical orientation.

Camera image number ❸ and **Camware Image Number** ❹ 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).
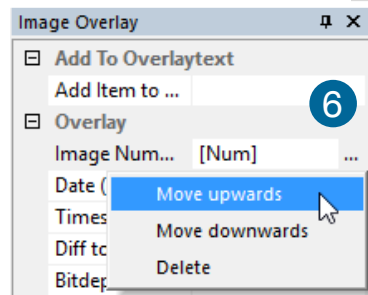
A preview of the image overlay is shown. ❺

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

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.** ❼

> **NOTE**
> This function does not overwrite image data.

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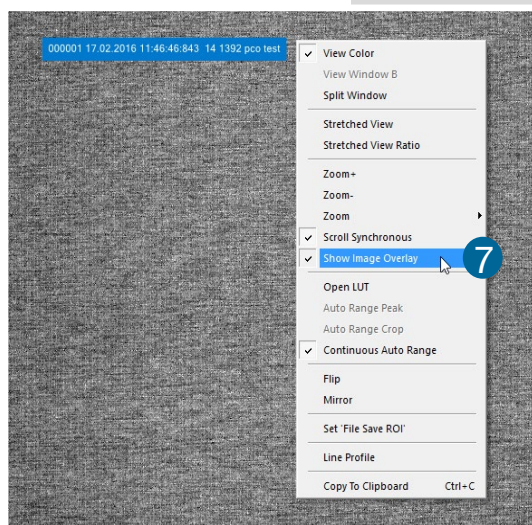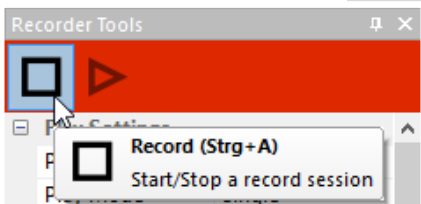
Record: in record state Camware software is highlighted in red.

Exposure time may be changed during recording. See **6.3 Camera Properties**.
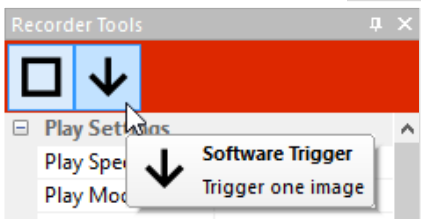
Software Trigger Mode: after record is started an arrow pointing downwards appears, which releases a single trigger (see **6.3.1***)*.

Play Settings ❶
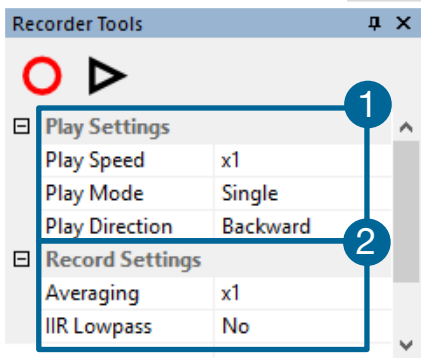
Play Speed: selectable play speed from x1 to x256 or from 1 fps to 16 fps. E.g. in mode x1 a recording with 1000 fps is played with 25 fps.
1 fps means that only one frame per second is played.

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 ❷

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.
Image (actual) = Image (act - 1) * 0.9 + Image (new) * 0.1

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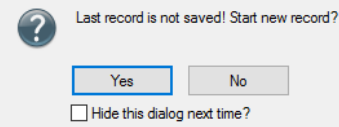
Reminder dialog: If you have already made a recording but did not save it, Camware will ask you to save the record before starting a new one.

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)
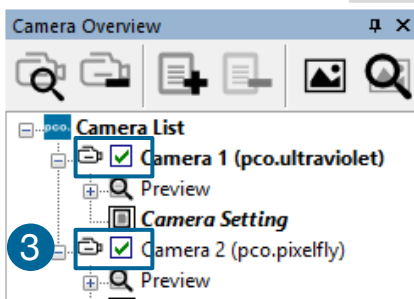
Recording with multiple cameras

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

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6.6 VIEW WINDOW
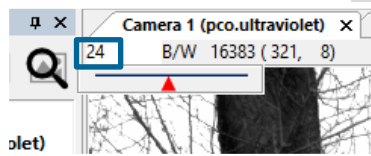
Fast–scroll through images

If you have recorded at least 50 images, you can scroll through the images quickly. To do this, hold down the left mouse button on the image number. Additionally you can enter the *desired image number* directly into the number field.

More View Windows
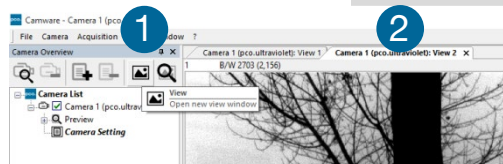
It is possible to open more view windows from one camera: just click on *open new view window* ① and Camware will create a new one ②.
Even when multiple view windows (or from multiple cameras) are open, the same image number is always shown in all of the view windows.

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

Split View Window
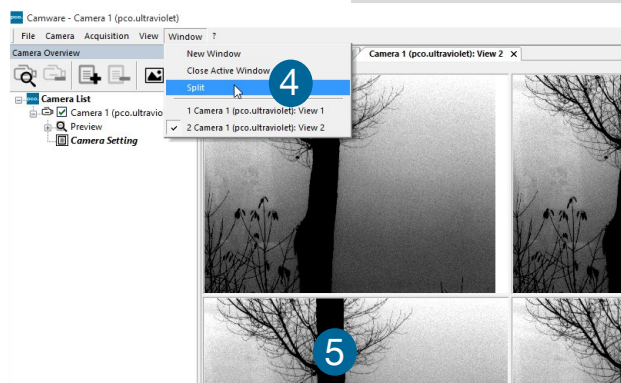
The view window can be split. Choose *Window → Split* ④ and a split cross will be shown. The size of splitted window elements is easily adjusted by grabbing and dragging the dividing lines ⑤.
The main reason for this function is to view four sections of the image in one view. Choose the *Zoom±* function 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
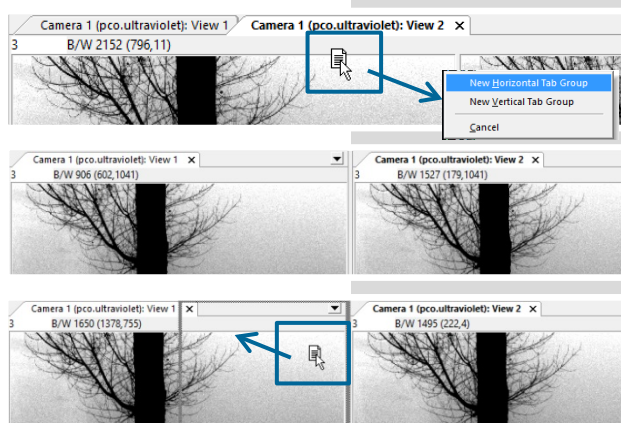
To view two tabs side by side or arranged one above the other just drag a tab and then Camware will ask wether you want to create a new horizontal or vertical tab group. Undo this very easily by draging the tab back to its former position.
This also applies for view windows of several cameras.

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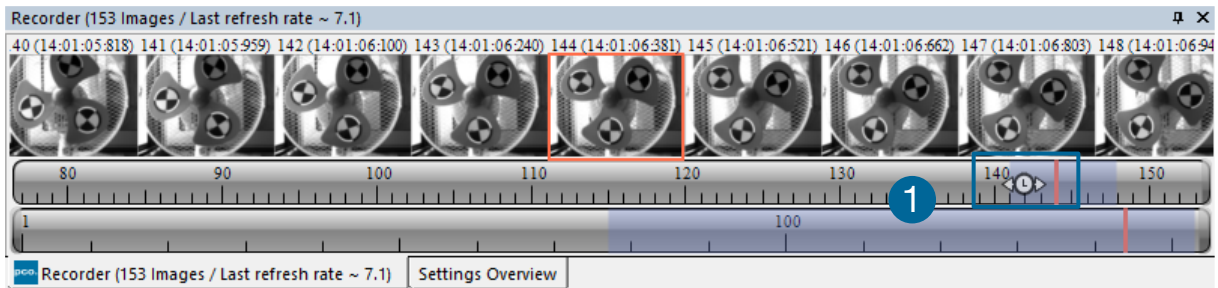
If you click (left mouse button) within the upper scale bar ❶, you can adjust the number of images which are shown by moving the mouse left or right. Minimum is **20** and maximum is **half of the recorded images** in this scale.

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.
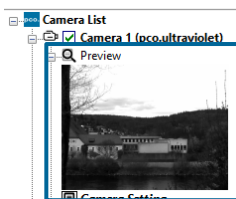
While quick scrolling, the **Preview** window will display the active image sequence. This allows to quickly scroll through the image sequence displaying the images in the **Preview** window forwards or backwards. The **View** window will not actively show live images during quick scrolling (only in 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.
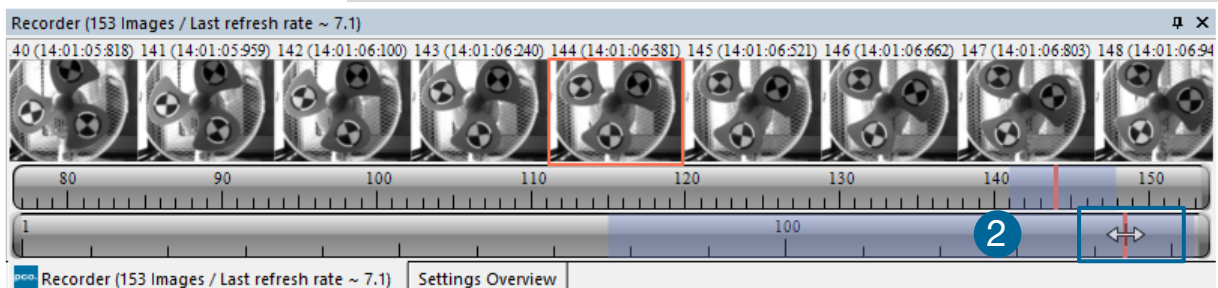
The second scale shows the total number of recorded images. It allows fast scrolling through the images ❷.

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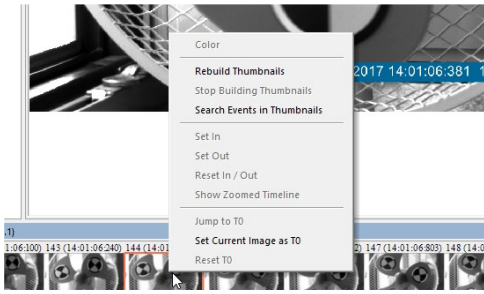
Right-click menu (click on thumbnails)
Allows to rebuild all thumbnails and to search for events.

Furthermore **Set In / Out** enables to set values for a sequence 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 **6.7.2**).
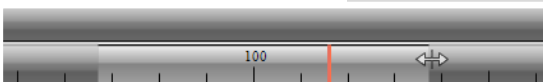
The **light gray area** in the upper scale shows an **In-Out** example area. Define easily a new area: just **right-click on the start and end frame** in one of the scales. The **In** image must be left side to the red bar, the **Out** image on its right side.
Adjust the **In / Out** area by holding down the left mouse button and sliding the borders.
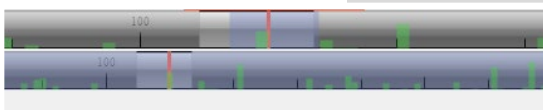
Search Events in Thumbnails: detected events are displayed as **green bars**.
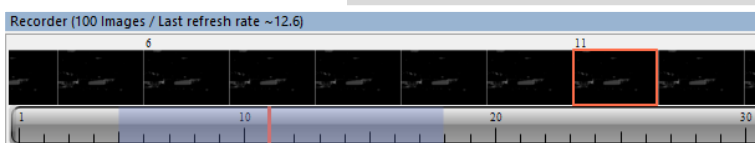
Too dark or bright thumbnails
If thumbnails are too dark or too bright, right-click in view window (see **6.9.8**) and select **Auto Range Peak** or **Auto Range Crop**. Then right-click on a thumbnail image and select **Rebuild Thumbnails**. Now the thumbnail images should comply with the view window.
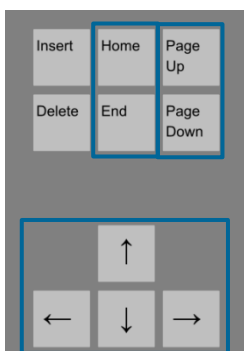
Use your keyboard to scroll through the Recorder Images

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.
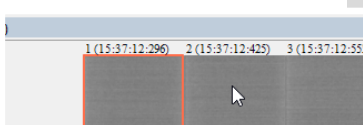
Adddtional short-cuts:
While mouse is in the thumbnail area in **Recorder (Images)**:
Press CTRL + left mouse button to jump to the **first** image
Press CTRL + right mouse button to jump to the **last** image

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6.8 SETTINGS OVERVIEW

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 under **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.ultraviolet
⑩	Ext. Sync. State	Not available for pco.ultraviolet

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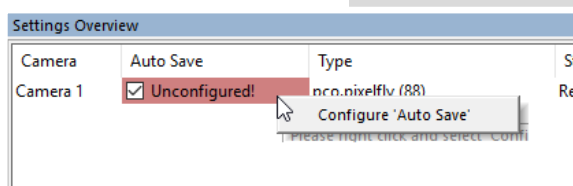
Enable **Auto Save** by clicking on the check box. The text will change to **Unconfigured!** (red background).

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 + 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.
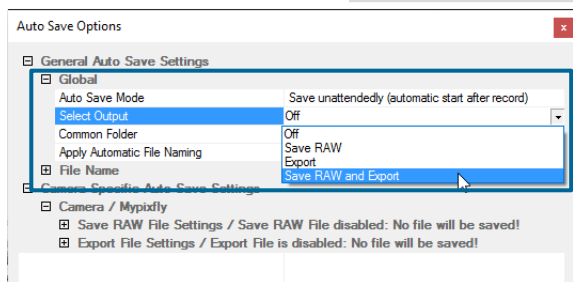
Select Output:

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
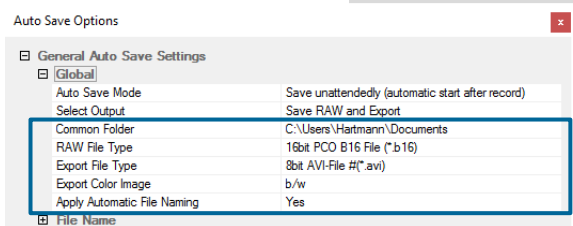
Common Folder: main folder for stored files
RAW and **Export file Type:** select the type of RAW and compressed file
Export Color Image: select if you want to export color images (only for color cameras)
Apply Automatic File Naming: if set to **yes**, your stored files are automatically named by Camware according to your automatic file name settings.

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General Auto Save Settings – File name
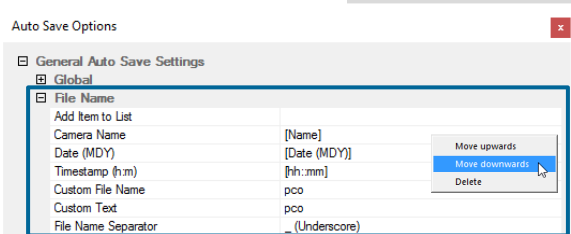
Set your file name individually by adding or deleting items. Position these elements as needed.

Camera Specific Auto Save Settings:
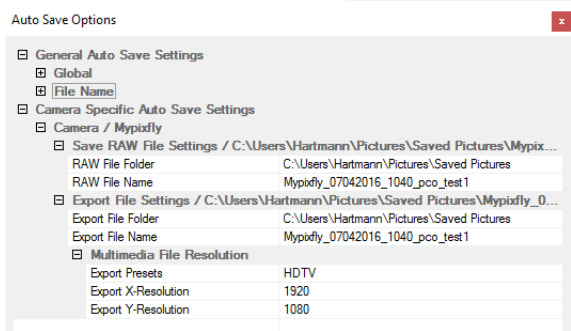
Configure camera specific settings for each connected camera.

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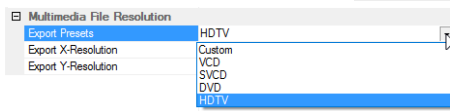
Multimedia File Resolution: set predefined video export resolution or enter a **Custom** x- and y-resolution.
It makes sense to set the resolution to the actual camera's resolution.

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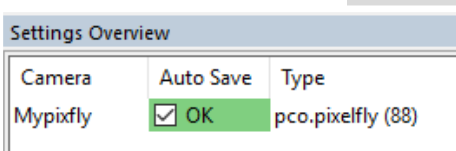
After configuration is finished, **Auto Save** status will be set to **OK** (green background).

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6.9 CAMWARE MENU TABS & FEATURES

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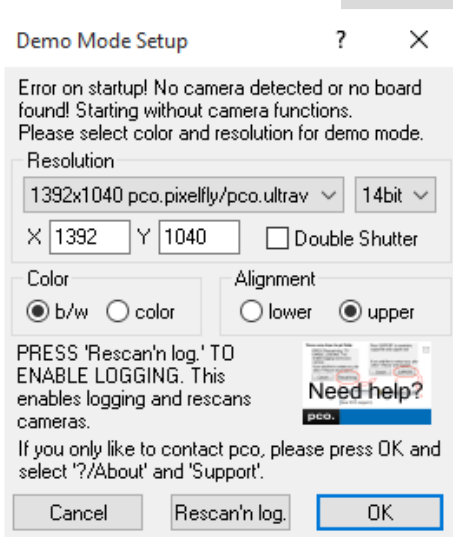
Upon start Camware, it automatically recognizes the camera type of the connected and running cameras.

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.

Need Help? Having troubles to run the camera, this window will pop up. See instruction in appendix **A3**.

Resolution
The drop down list displays the existing image sensor spatial resolutions of all PCO camera systems. Please select the specific resolution and bit depth of the images to be opened. If Double Shutter images have been recorded and should be opened, Double Shutter Mode should be ticked.

Color
With the radio buttons, the user can specify whether the image type is monochrome (b/w) or color.

Alignment
These two radio buttons adjust whether MSB (most significant bit) aligned (upper) or LSB (least significant bit) aligned (lower) images have been stored.
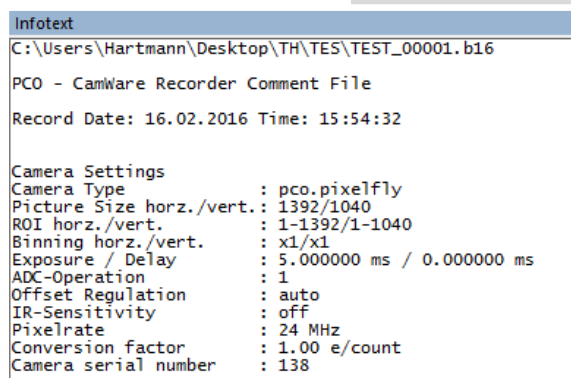
Infotext

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.

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6.9.2 FILE MENU

File	Camera	Acquisition	View	Window	?	
	Open Raw File					CTRL+I
	Open Raw Recorder Sequence					CTRL+R
	Save Raw File					CTRL+E
	Save Raw Recorder Sequence					CTRL+S
	Export File (not reloadable!)					CTRL+T
	Export Recorder Sequence (not reloadable!)					CTRL+O
	Options					
	Open AVI Codec Dialog					
	Load Lookup Table					
	Direct Record to File					
	Start Auto Save					Shift + A
	Exit					

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)
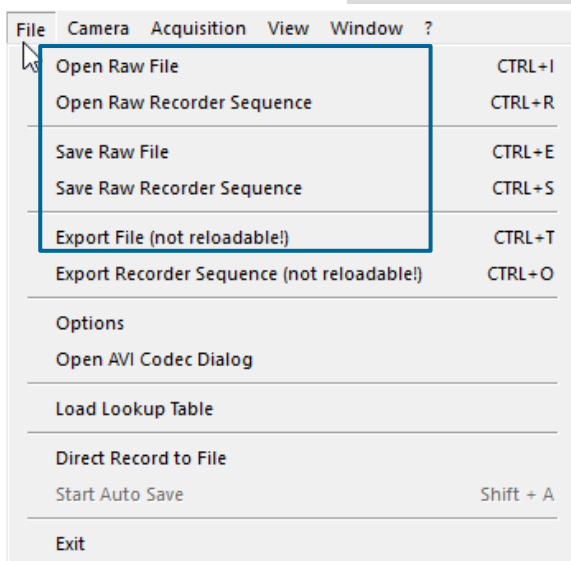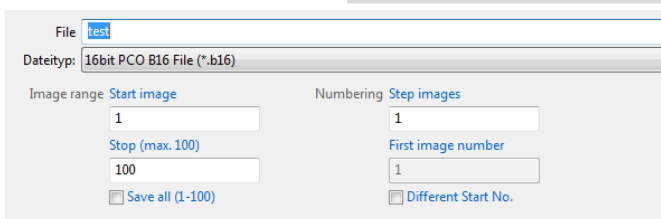This command is used to import a sequence of images. If more than one camera is connected and an image window is currently open, the sequence will be loaded to the active window. If no image window is open, the images will be loaded to camera #1. This command opens the Open file dialog box. Only files 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 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, all current images may be saved 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)

File	test	
Dateityp:	16bit PCO B16 File (*.b16)	

Image range	Start image	Numbering	Step images
	1		1
	Stop (max. 100)		First image number
	100		1
	☐ Save all (1-100)		☐ Different Start No.

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**

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Export Recorder Sequence (not reloadable!)	CTRL+O
Options	
Open AVI Codec Dialog	
Load Lookup Table	
Direct Record to File	
Start Auto Save	Shift + A
Exit	

Export Recorder Sequence (not reloadable!)
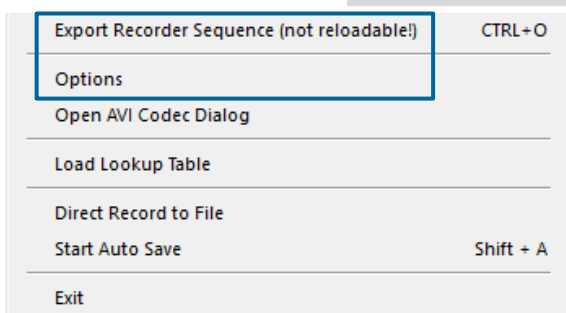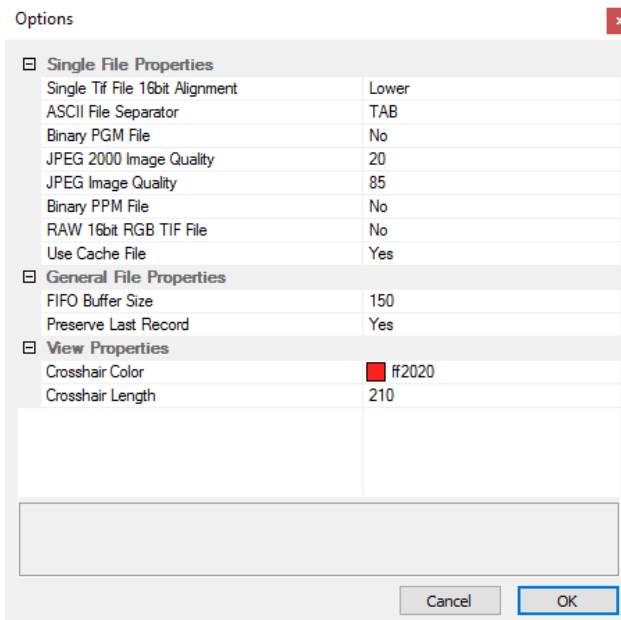Use this command to export a sequence of images. If more than one camera is connected and an image window is currently open, the record of the window which has got the input focus will be saved. If no image window is open the Export Recorder Sequence menu does not appear. This command opens the Export recorder box. Files with the extensions fts, tif, bmp, asc, avi, mpg, jpg, jp2, and wmv can be exported (see Appendix **A3**). For *Auto File Save* see **6.8.1**

Options

Options

⊟ Single File Properties	
Single Tif File 16bit Alignment	Lower
ASCII File Separator	TAB
Binary PGM File	No
JPEG 2000 Image Quality	20
JPEG Image Quality	85
Binary PPM File	No
RAW 16bit RGB TIF File	No
Use Cache File	Yes
⊟ General File Properties	
FIFO Buffer Size	150
Preserve Last Record	Yes
⊟ View Properties	
Crosshair Color	ff2020
Crosshair Length	210

Cancel   OK

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.ultraviolet)

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.
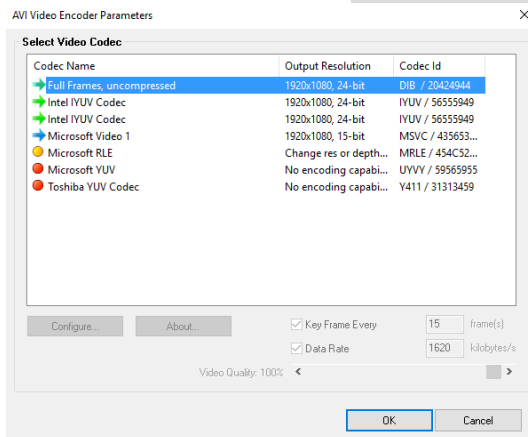
View Properties:

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**

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Open AVI Codec Dialog

Settings in **Auto File Save** affect stored video sequences stored video sequences.
You only need to set this option, if you use **Auto File Save** see **6.8.1**

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.
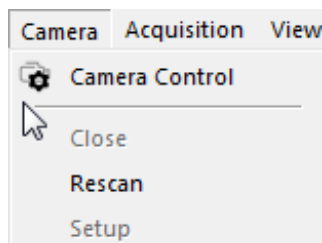
Start Auto Save
Only available if **Auto Save** is activated, see **6.8.1**

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
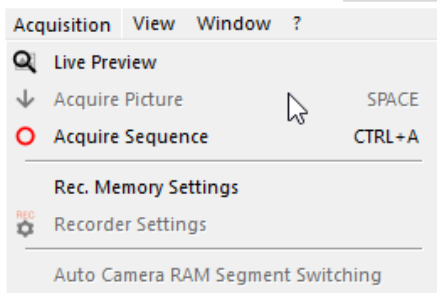Use this command to open the camera control window.

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.ultraviolet)

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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.
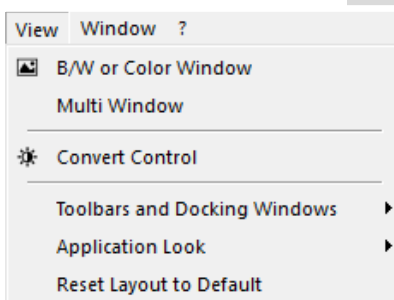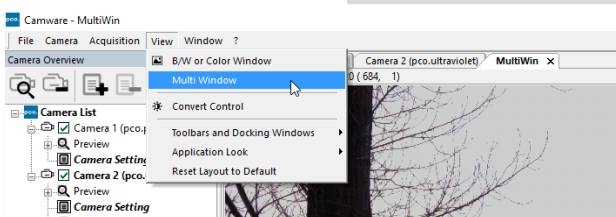
Rec. Memory Settings
Sets the number of images recorded in one sequence. The maximum is defined by pre-established RAM size.

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 Ring Buffer is full for the first time (Ring Buffer mode).

Convert Control
See **6.3.6**

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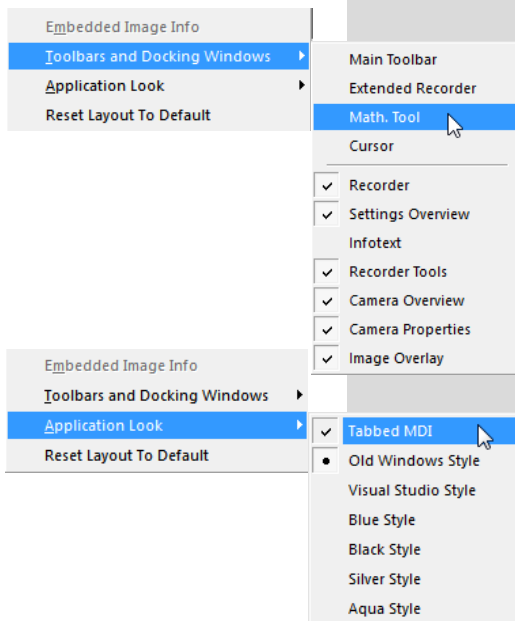
Toolbars and Docking Windows

Standard toolbars of Camware 4 are Recorder/ Recorder Tools / Camera Overview / Camera Properties and Image Overlay. *Additional Toolbars* known from Camware 3.x are displayable, but not essentially needed: Main Toolbar / Extended Recorder / 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.
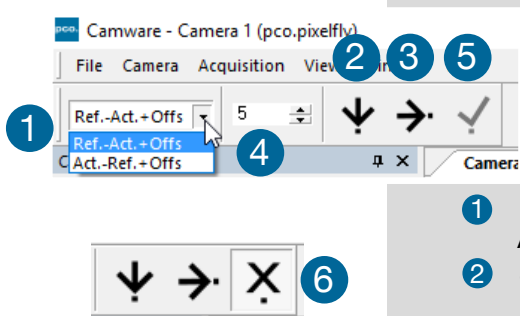
Math Tools

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
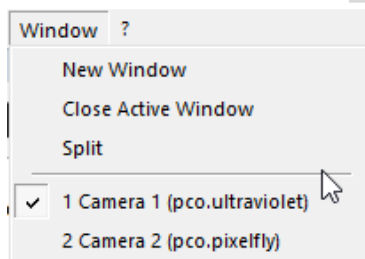5. enable math function
6. disable math function
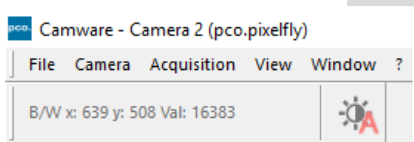
Cursor

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.

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6.9.6 WINDOW MENU

New Window
Opens a new one.

Close Active Window
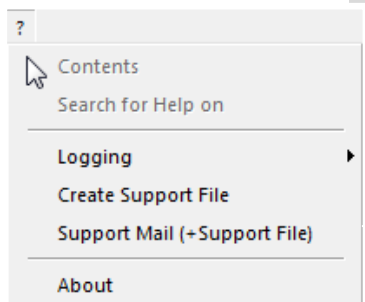Closes the active one.

Split
The view window will be split in four quarters.

Camera overview
Shows all connected cameras, e.g. *Camera 1 (pco.ultraviolet)*

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 pco.ultraviolet. With activated log files it is possible to create a support file. Send it to the PCO support (see **A3.3**).
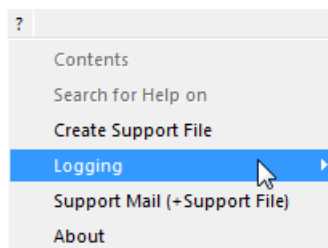
Logging
Enable Logging: Activates Camware log files (this cuts down camera's performance)
Clear Logfiles (only visible if logging is enabled): erases all actual log files
Explore Logfiles: opens windows explorer
Disable Logging (only visible if logging is enabled): disables logging

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

About Camware
This window shows program information.

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6.9.8 VIEW WINDOW MENU

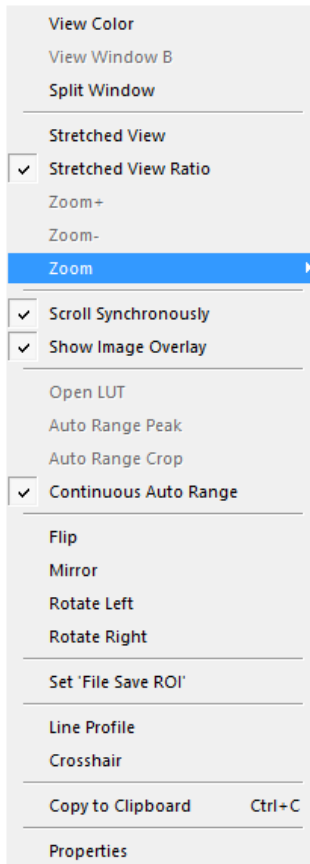| Menu |
| --- |
| View Color |
| View Window B |
| Split Window |
| Stretched View |
| ✓ Stretched View Ratio |
| Zoom+ |
| Zoom- |
| **Zoom** ▶ |
| ✓ Scroll Synchronously |
| ✓ Show Image Overlay |
| Open LUT |
| Auto Range Peak |
| Auto Range Crop |
| ✓ Continuous Auto Range |
| Flip |
| Mirror |
| Rotate Left |
| Rotate Right |
| Set 'File Save ROI' |
| Line Profile |
| Crosshair |
| Copy to Clipboard   Ctrl+C |
| Properties |

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: Double Shutter activation switches to window B window B (second image).

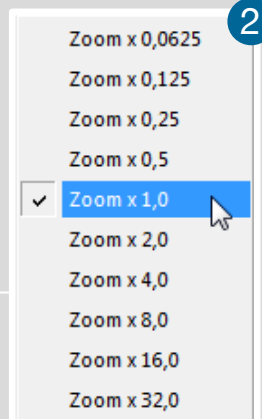*Split window:* ❶ splits the View window in four parts. Double click on separator to undo.
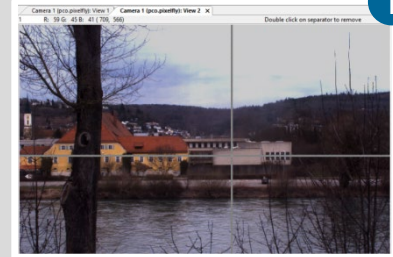
Stretched View: image will be fitted into the display window.

Stretched View Ratio: aspect ratio is maintained.

Zoom +/-: ❷ 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**

Zoom menu
Zoom x 0,0625
Zoom x 0,125
Zoom x 0,25
Zoom x 0,5
✓ Zoom x 1,0
Zoom x 2,0
Zoom x 4,0
Zoom x 8,0
Zoom x 16,0
Zoom x 32,0

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

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Flip/Mirror: image will be flipped or mirrored.

Rotate Left/Right: rotates the image in steps of 90°.
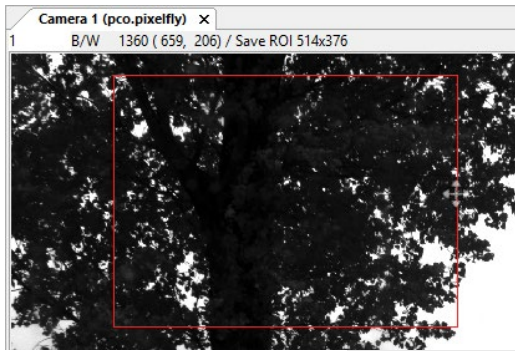
Set 'File Save ROI': if you want to save just a part of the recorded image (region of interest), it is possible to draw a rectangle with the mouse. This rectangle is valid for all recorded images and can be dragged at its edges.
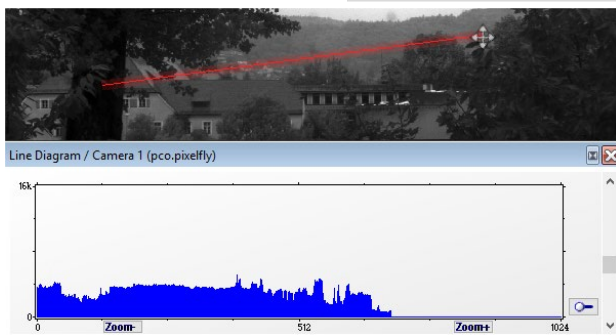
Line Tool: point the mouse where the line should start and left-click. Move the mouse to the desired line end and left click again. The line may be stretched, shrunk or moved by grasping its end point. A ***Line Diagram*** opens. The graph in the length of the line (units: pixel) is displayed showing 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, just drag it by mouse. Reset it to center position by double-click into the center of the crosshair.

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

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

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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*.

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.
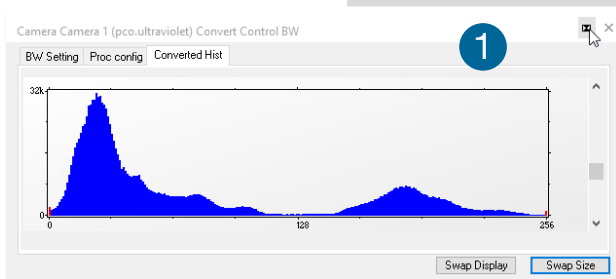
Fold Up Window

The Convert Control windows can be minimized / folded up ①. Just move the pointer over the bar and the window will unfold again ②.
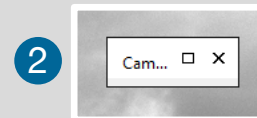
Short Cut List

- 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 File: STRG + I
- Open Raw Recorder Sequence: STRG + R
- Save Raw File: STRG + E
- Save Raw Recorder Sequence: STRG + S

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APPENDIX

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A1 TECHNICAL DATA

A1.1 DATA SHEET

image sensor	
type of sensor	ICX 407BLA interline CCD
resolution (h x v)	1392 x 1040 pixel (normal = full resolution)
	800 x 600 (centered)
pixel size (h x v)	4.65 µm x 4.65 µm
sensor format / diagonal	1/2" / 8 mm
shutter mode	Global (snapshot)
MTF	107 lp/mm (theoretical)
fullwell capacity	14000 e⁻
	24000 e⁻ (binning)
readout noise	7 - 9 e⁻ rms @ 12 MHz (typical)
dynamic range	1750 : 1 (65 dB)
	3000 : 1 (69.5 dB) binning
quantum efficiency	40 % @ 193 nm
spectral range	190 nm .. 1100 nm
dark current	1 e⁻/pixel/s @23°C
DSNU	2 e⁻ rms
PRNU	< 1%

camera	
frame rate	7.3 fps (normal = full resolution)
	11.7 fps (centered 800 x 600)
exposure / shutter time	1 µs .. 60 s
dynamic range A/D	14 bit
A/D conversion factor	0.8 e⁻ / count
	1.4 e⁻ / count
pixel scan rate	12 MHz
binning (h x v)	1 x 1 .. 4 x 4
non linearity	< 1 %
smear	< 0.005 %
anti-blooming factor	> 200 (standard 100 ms exposure)
interframing time	< 1 µs (optional)
trigger input signals	Software / TTL level
trigger output signals	3.3 V LVTTL level
data interface	USB 2.0

general	
power supply	9 .. 28 VDC (12 VDC typ.)
power consumption	< 3 W
weight	0.35 kg
operating temperature	+10°C .. +35°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.

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A1.2 QE CURVE
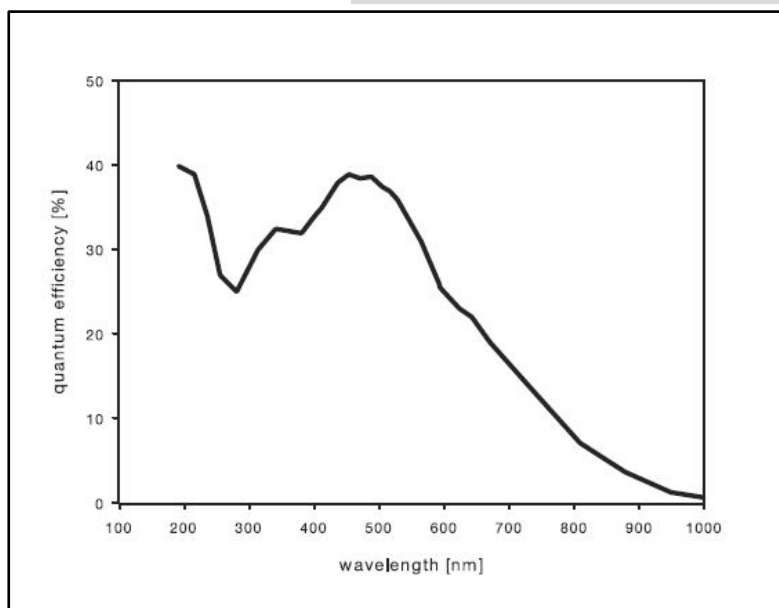
Peak: 40% @ 193 nm

Spectral range: 190 to 1100 nm

A1.3 TRIGGER INTERFACE

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

For more information confirming trigger modes see **A1.3** and **6.3.1**.

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A1.4 MECHANICAL DIMENSIONS

All dimensions given in millimeter.
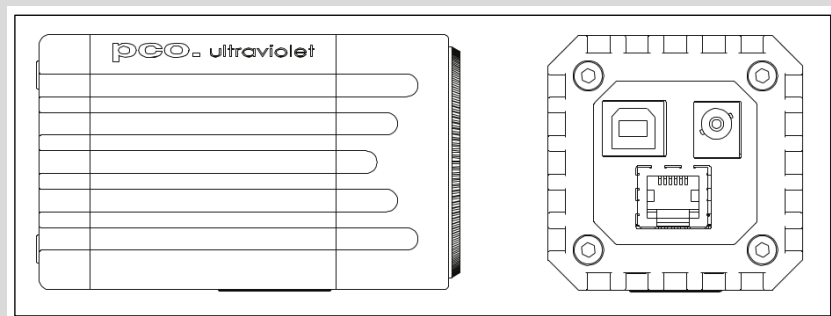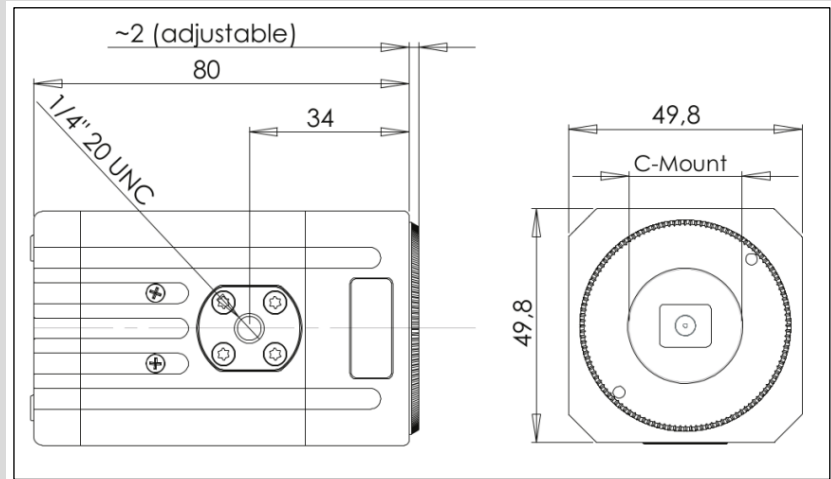
C-Mount flange focal distance: 17,52 mm

A1.5 NO INPUT WINDOW

NOTICE

The ***pco.ultraviolet does not have an input window*** to protect the sensor.
- ➔ If the lens is removed you have direct access to the sensor surface.
- ➔ The sensor surface itself has a glass, but this glass is very sensitive and can be easily damaged (e.g. scratches).
- ➔ Therefore, please be very careful when removing or changing optical components.

To clean the sensor surface only use commercially available ***can of compressed air*** or contact your local PCO distributor for further cleaning instructions.

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A1.6 REAR PANEL
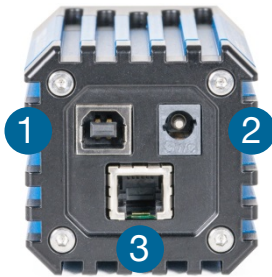
USB 2.0 plug ①

Power socket ②:
Input: 9…28V; max. 3W

RJ 11 connector ③

Pin 1

Pinout of RJ11 connector

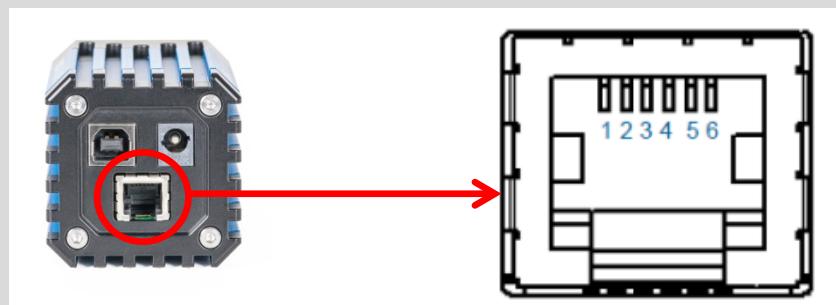| Pin	Description
1	GND
2	Exposure out (TTL 3V)
3	Busy out (TTL 3V)
4	not used
5	Trigger in (TTL 0…5V)
6	+12V (alternative power supply)

Pin Position

1 2 3 4 5 6

Timing & Signals

busy = TRUE / high	camera is recording or sensor readout in progress
busy = FALSE / low	external trigger is ready to accept
exposure = TRUE / high	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.

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A2 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 optionally for additional information. There 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 filed 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/with 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 ... 266	internal use	
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	
…	…	

PCO recommends 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

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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.

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A3 CUSTOMER SERVICE

A3.1 SERVICE

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

A3.2 MAINTENANCE

CAUTION

UNPLUG CAMERA BEFORE CLEANING
Risk of injury due to electric shock!
➔ Unplug the camera from any power supply before cleaning it.

NOTICE

NO INPUT WINDOW
The pco.ultraviolet does **not** have an input window to protect the sensor. If the lens is removed you have direct access to the sensor surface.
➔ The sensor surface itself has a glass, but this glass is very sensitive and can be easily damaged.
➔ Therefore, please be very careful when removing or changing optical components.
➔ To clean the sensor surface only use commercially available **can of compressed air** or contact your local PCO distributor for further cleaning instructions.

NOTICE

BODY CLEANING
➔ Use a soft, dry cloth for cleaning the camera.
➔ 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.

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.

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A3.3 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	
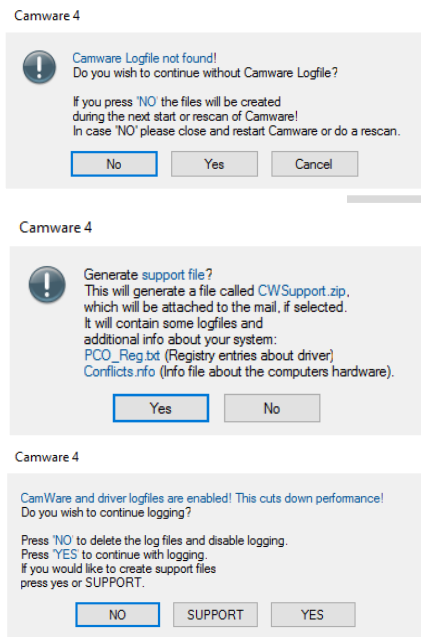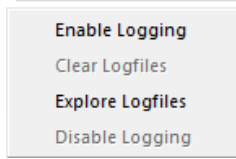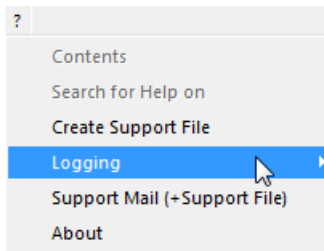
How to create a logfile:

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

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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.

A3.4 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.

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A4 INDEX

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

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ABOUT PCO

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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.

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