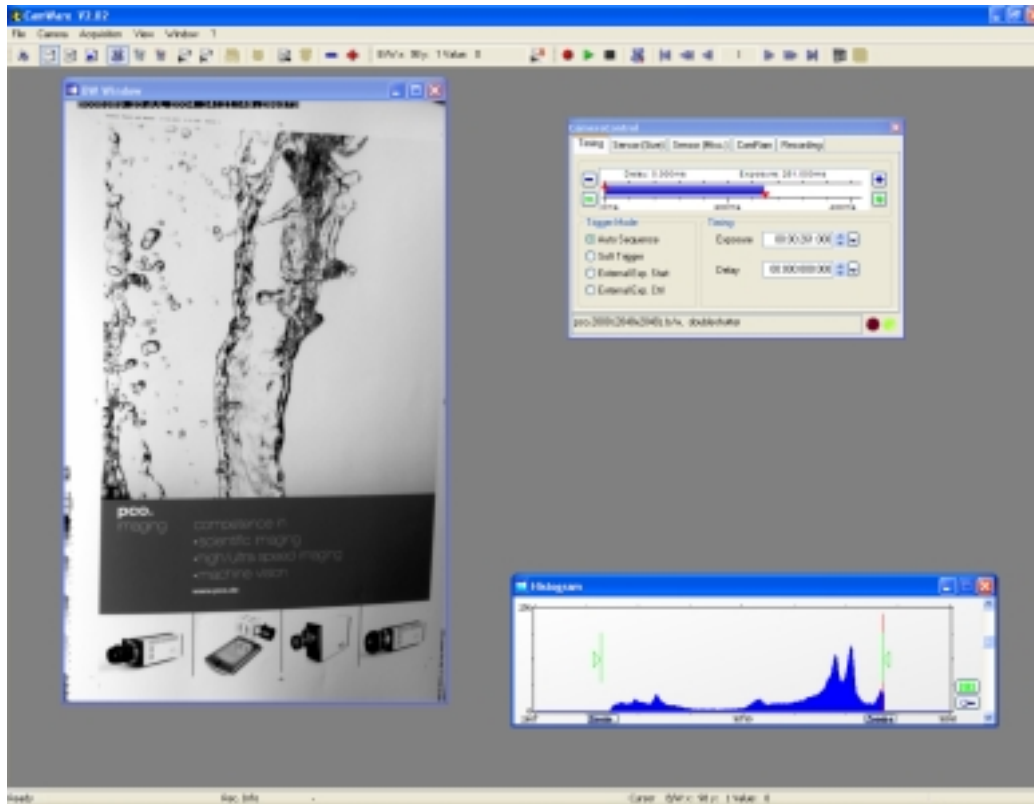


the  
cooKe  
corporation

# pcO.camware

## User's Manual



[www.cookecorp.com](http://www.cookecorp.com)

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## 1 Camware

Camware is a 32bit Windows application for the Windows 2000 (with service pack  $\geq 4$ ) and Windows XP (with service pack  $\geq 1$ ) operating systems.

Camware is a control application for the PCO camera systems: pco.camera, sensicam family, pixelfly and dicam pro.

Using camware, all camera parameters are user selectable. Recorded images are displayed on the monitor and can be saved, for example on the connected computer's hard disk. The recorder function records of image sequences and displays them as "movies". This function allocates a memory space in the computer's RAM memory into which the images are transferred. The maximum memory space for recorded images depends solely on the available RAM size of the computer.

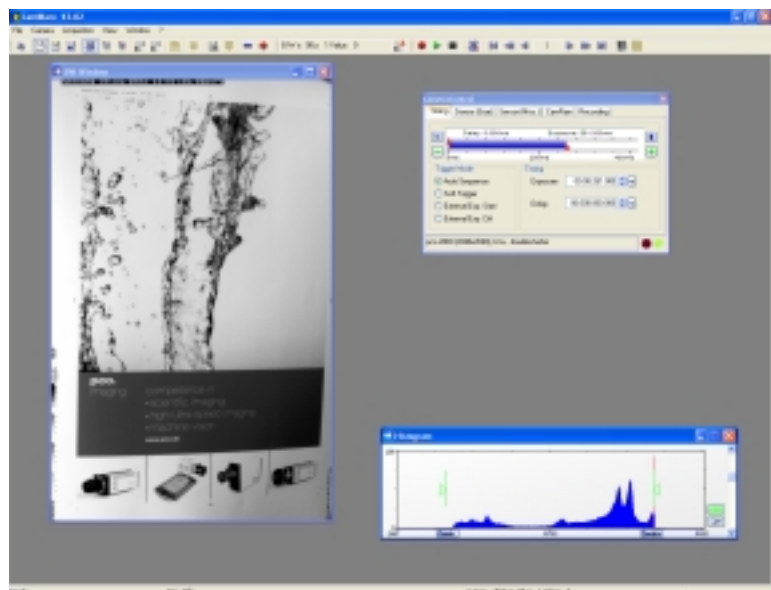
When camware is started, it automatically recognizes the camera type, which is connected to the computer and switched on.

Before starting camware, make certain that the frame grabber (or an appropriate standard interface such as IEEE1394 firewire or camera link), the corresponding driver, the camera system and the camware must have been installed according to the camera manual instructions.

When camware is installed, the default directory location is:

...programs\Digital Camera ToolBox

After starting camware, the following main window should be visible:



## 1.1 Signs and Symbols

The following signs and symbols are used throughout this manual:



Disregarding this symbol and the accompanying text warning notices may result in the risk of death.



Disregarding this symbol and the accompanying text warning notices may result in system damage and data loss.



*This symbol and the accompanying text point out tips, hints and other useful information.*

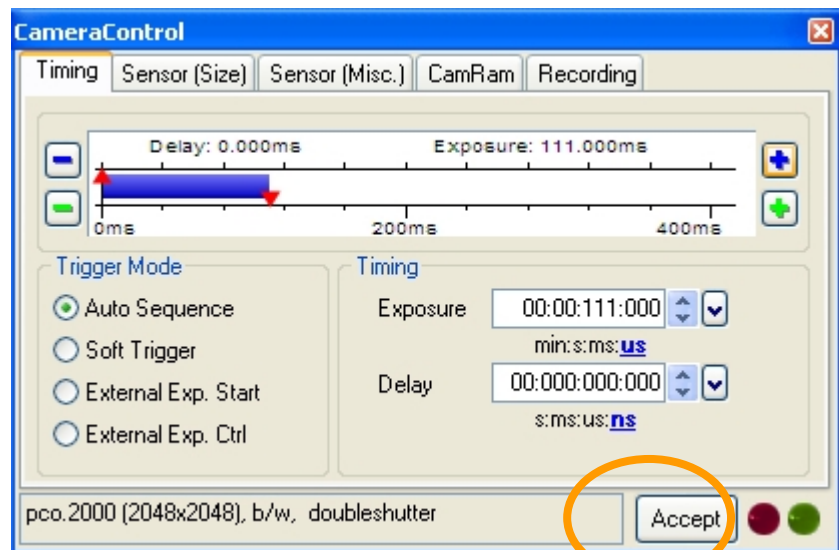
- These Symbols denote enumerations and listings.

-

Text which refers to software menus and related information is written in Courier typeface with a fixed width.

## 1.2 New Features of pco.camera

### 1.2.1 Accept Button

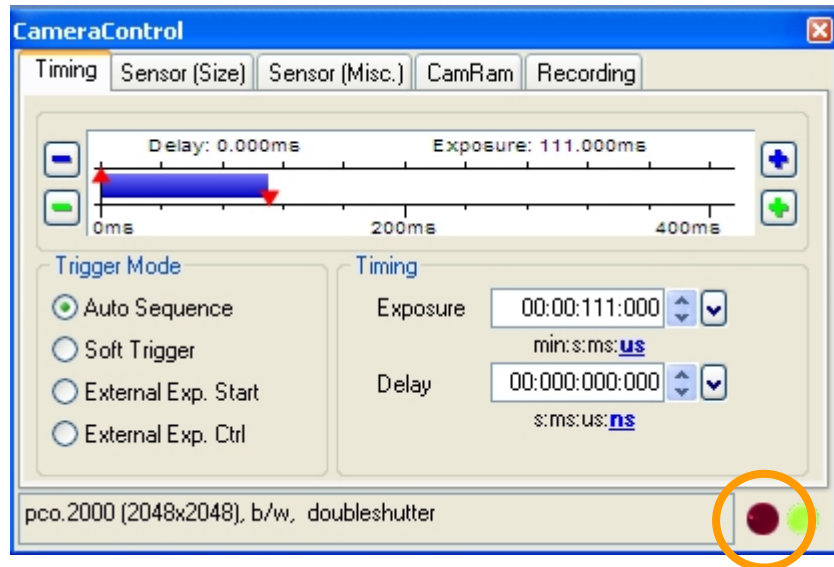


Important changes in the general structure of the relationship between the camera and the computer for pco.camera have resulted in the camera, itself, doing more "guess" work, which had previously been done by the computer.



Changes to the camera control sheets must be completed by pressing the "Accept" button in the lower right corner of the "Camera Control" window. If the "Accept" button is not

pressed, these changes will be ignored and lost. If the changes are within the allowed condition limits of the camera, a message is sent to the computer, the button disappears and the green lamp will be highlighted. If an illegal change was attempted, the camera will not accept the change and the red lamp will be highlighted.



## 1.3 Image Data Alignment

### 1.3.1 MSB (Most Significant Bit) Alignment

With the new pco.camera system, camware was converted to an MSB image data alignment. This change was in response to customer comments, that only black images could be seen, when the image files were opened with image processing software. This happened because the 16bit values were filled with real intensity values for example a maximum of 4096 counts for a 12bit camera. If a 16bit image was opened, in most cases the displayed image would be scaled to the absolute maximum of 65536, of which 4096 is only a small amount. As a consequence, the displayed image appeared black and seemed to be empty.

For all image data, it doesn't matter which dynamic (10bit, 12bit or 14bit) are MSB or left aligned. This means, that all corresponding data are shifted or multiplied, and that the maximum possible value is stored as the maximum 16bit number (65536). As a result, even 10bit data appears larger, because a full range pixel value of 1024 for 10bit would be stored as 65536. Every pixel value has been multiplied by 64 (2) to achieve the MSB alignment.

If necessary for image processing purposes, the original 10bit values can easily be reconstructed by a simple division by 64 for each pixel. No image information is lost, distorted or changed by the MSB alignment.



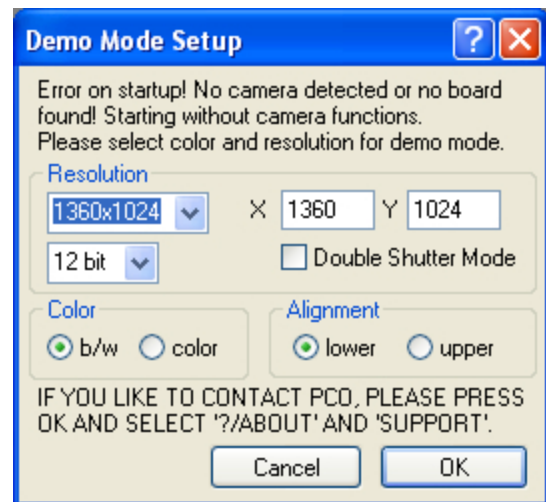
### 1.3.2 LSB (Least Significant Bit) Alignment

In earlier versions of camware, image data was stored using LSB alignment. However, this method had shortcomings and is no longer used in camware. Using LSB alignment the pixel values are stored as they are recorded. Since there are no 10 or 12 or 14bit image formats, only 8bit and 16bit, all image types must be stored as 16bit images.

LSB alignment is also called right aligned. The disadvantage of some image processing software packages is that they open images and display them simply minimum-maximum scaled to the data format instead of the image content. Therefore, a maximum exposed 10bit image (1024 counts) will appear totally black when stored as 16bit image data. The software scales from 0-65536 for display of 0-255 grey values, resulting in the darkest grey level step of 8192 counts, which is larger than 1024. As a result, no image can be seen.

To solve this problem, now camware stores images MSB aligned.

### 1.4 If no camera is connected



If camware is started with no camera connected to the PC or with cameras switched off, it starts in demo mode, which means that all image processing features are available. The user only has to tell camware which type of images will be opened. For that purpose, the "Demo Mode Setup" window opens and asks for the corresponding input.

#### Resolution

The drop down list offers the existing image sensor spatial resolutions of all PCO camera systems. The user selects the resolution of the images to be opened. Alternatively, the spatial resolution can be adjusted by activating the text fields and typing in the values:

X: horizontal resolution

Y: vertical resolution

The second drop down list, "12bit", offers the selection of the dynamic resolution (number of grey values in the image).

Furthermore, if double shutter images have been recorded and should be opened, the corresponding checkbox should be checked.

Color

With the radio buttons, the user can specify whether the image type is monochrome or color.

Alignment

These two radio buttons adjust whether MSB aligned ("upper") or LSB aligned ("lower") images have been stored (see chapter before).

## 2 Quick Overview

The toolbar buttons are pictured along with the corresponding chapters, denoted by brackets, for further explanations.



Print (4.1.9)



B/w window (4.4.1) - color window (4.4.2) - histogram (4.4.3)



Camera Control (3) - convert control b/w (4.4.4) - convert control color (4.4.5)



Auto range peak (5.8) - auto range crop (5.9) - auto balance color (5.10)



Auto exposure (4.2.6)



Live preview (4.3.1) - acquire picture (4.3.2)



Master gain (5.14)

B/W x: 271 y: 167 Value:13925

Pixel value (5.15)



Start record (5.17) - play record (5.18) - stop record (5.19)



Setup recorder (4.3.5)



Replay navigation (5.21)



Recorder browser (4.4.6)



Multi window (4.4.7)



Mathematical functions (4.1.10)

## 3 Camera Control

The "camera control" window is the main interface for all camera settings. Here, camera delay and exposure times are adjusted, vertical and horizontal binning can be selected, the camera can be set to various trigger modes, a region of interest (ROI) can be selected and information about the camera is displayed.

The camera control window can be started by selecting the proper command in the "Camera"-Menu or by pressing the following button:



Camware automatically detects the camera type

### 3.1 pco.camera family



This section describes the settings for the pco.camera system. The camera control dialog always adapts to the camera type connected. For pco.camera the camera control settings are spread over five property sheets.

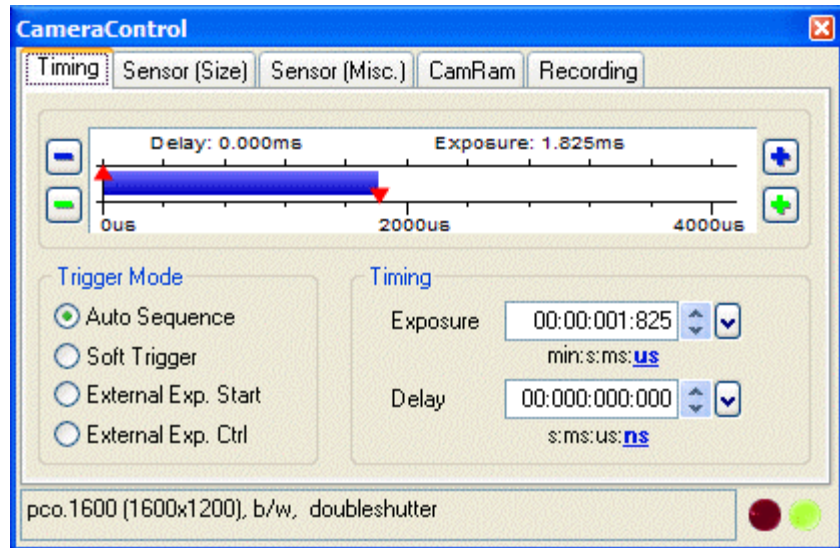


The most important change in the use of the camera control for the pco.camera system is that changes that have been made within the camera control window must be sent to the camera to be acknowledged. Therefore, after changes in each sheet, the visible "accept" button must be pressed. After that, the changes will be sent to the camera. A green lamp in the lower right corner of the control window indicates that the changes have been acknowledged and made. A red lamp signals an error.

If the "accept" button were not pressed, the user would continue recording with previous or unknown settings. The camera control dialog does not revert to previously "accepted" settings.

#### Timing

The "Timing" sheet enables the control of delay and exposure time as well as the "Trigger Mode".



### Trigger Mode

If "Auto Sequence" is selected, press the "Start Record" button to begin recording. The camera will optimize the image recording to achieve the best possible frame rate.

Use the "Soft Trigger" if single images need to be recorded with GUI control. The user must press the "Start Record" button to enable the recording. Then single images can be acquired by pressing the "Single Trigger" – button (see 5.13 and 5.17) with the yellow flash, next to the "Start Record" button.

If "External Exp. Start" is selected, the image acquisition is triggered by an external signal. It is also possible to force a software trigger with the "Single Trigger" – flash button.

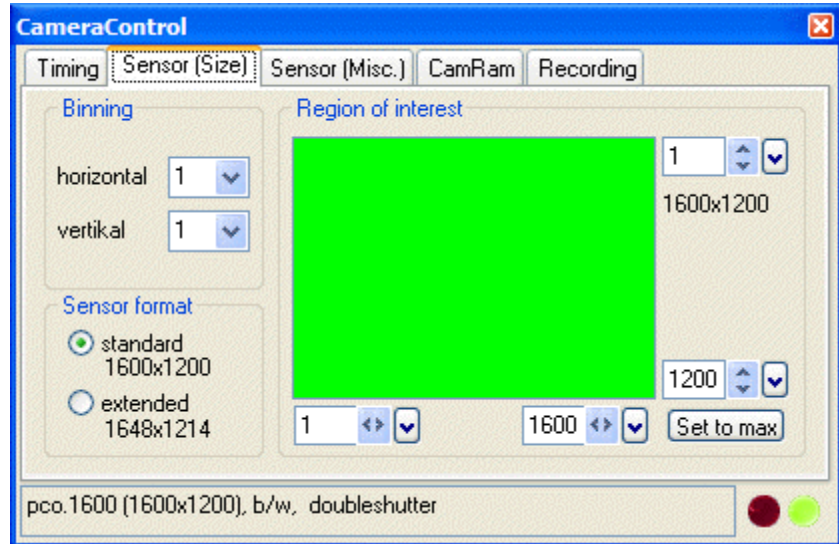
If "External Exp. Ctrl" is selected, an external signal, which is applied to the trigger input at the pco.power, controls the start and the duration of the exposure.

### Timing

The timing values (exposure and delay times) can be adjusted in various ways. It is possible to click onto the red triangles and move them with the mouse, or to change the values using the edit control. Here, the values can be edited directly, by clicking into the edit control, or by using the up/down control or the slider on the right. The slider and the up/down control refer to the blue highlighted unit.

### Sensor (Size)

Within the Sensor (Size) sheet it is possible to adjust the sensor format, the binning and the region of interest (ROI).



### Binning

Binning combines neighbouring pixels (in either the horizontal or vertical direction) to form super pixels. It increases the light signal of the remaining pixels and decreases the spatial resolution of the total image, which is recorded. To a certain extent, it increases the frame rate.

### ROI

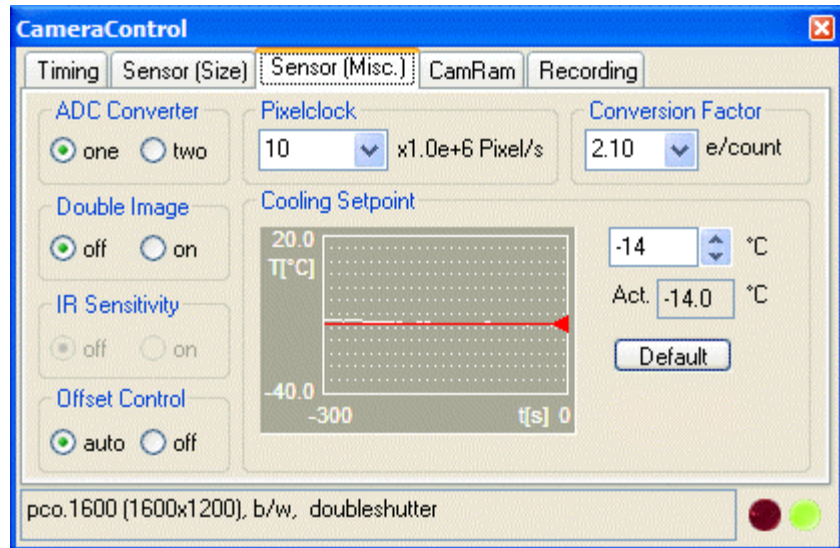
The ROI (region of interest) selects only a part of the sensor to be read out, in order to speed up the frame rate and to save memory. The ROI can be changed by clicking on the ROI window while selecting a new rectangle, or by directly accessing one of the four ROI limiting values. They can be edited within the edit box, increased or decreased by the up/down control or by using the slider. Additionally, the ROI setting can be reset to maximum extent by pressing the "Set to max" button. Another option allows ROI mouse adjustment, as described in Section 7.2.

### Sensor format

Some image sensors have the option to readout a standard size (effective pixels recommended by the sensor manufacturer) or an extended size, which adds further exposed pixels, which can be helpful for calibration or control purposes.

### Sensor (Misc.)

The Sensor (Misc.) sheet offers options to control image quality and additional camera system parameters.



### Pixelclock

The Pixelclock sets the clock frequency and therefore the image sensor readout speed. The lower the pixelclock is set, the higher the image quality will be. At lower pixelclock settings, it is sufficient to read out at a lower bandwidth, which results in lower readout noise. The higher the pixelclock is set, the faster the image sensor is read out by the camera, achieving higher frame rates.

### ADC Converter

Using two analog-to-digital converters (ADC), rather than one, will decrease the readout time. Using two ADCs will force the ROI to be symmetrical in the horizontal direction. With two ADCs, the left half of the image is converted by the first ADC and the right half of the image is simultaneously converted by the second ADC. The readout time will be shortened by half.

### Double Image

These radio buttons select the camera's double shutter / exposure function such that the readout time of the first image can be used to record a second subsequent image. This feature is widely used for particle image velocimetry (piv) measurements.

### IR Sensitivity

If available, these buttons use a special image sensor control method, allowing greater sensitivity in the near infrared spectral range, in most cases, at the expense of decreased anti-blooming performance.

### Offset Control

To deliver all image evaluation information, it is necessary to add a certain signal level to the real signal, to enable the measurement of the total noise floor (if the offset would be zero, an unknown amount of noise would be cut off, since a negative

light signal is not possible). The stability of this offset is usually guaranteed by a proper temperature control and a software control, which uses the information of "dark pixel" information from the sensor limits. Further, algorithms must be applied to match the sensor performance if 2 ADCs are used for readout. All this can be done automatically (Offset Control - Auto) or can be switched off (Offset Control - Off), for total user control. The addition of an offset level is not influenced by these radio buttons, but rather through software control.

### Conversion Factor

Using the values from the dropdown list, the corresponding conversion factor can be selected. The conversion factor defines how many charges (electrons), which have been generated by light in the image sensor in each pixel, are necessary to generate one count (one intensity level) in the digital image. Therefore, the conversion factor describes the gain that is applied to the signal before it is converted into a digital value.

### Cooling Setpoint

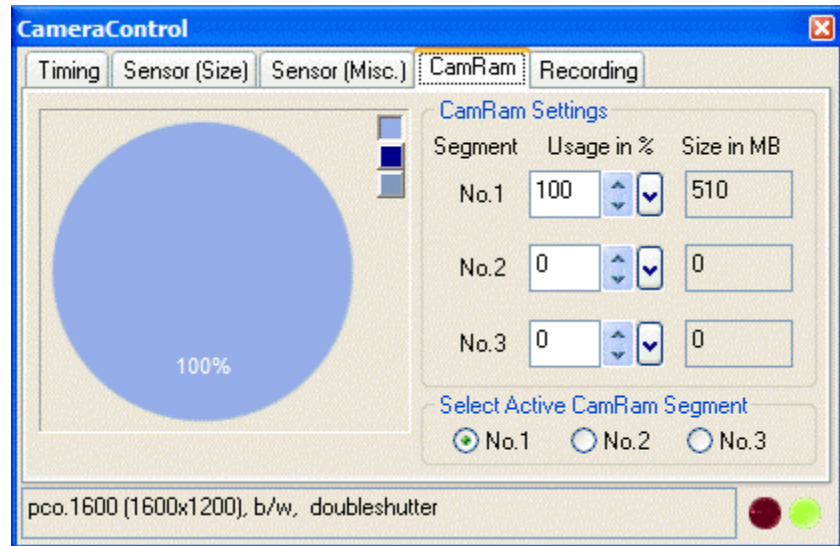
The cooling setpoint (if available) adjusts the temperature that should be reached by the camera system. The user should not set the cooling setpoint to the lowest possible temperature. In case ambient temperature drifts, the controller will not have any overhead available for adjustment. The window shows the readout temperature of the image sensor and the adjusted temperature. The adjustment controls should be used to select an appropriate temperature. The lower the temperature, the less dark current is accumulated, which is only important for longer exposure times. If exposure times are in the ms range or shorter, the lower temperature has no major influence. To keep the offset as constant as possible, moderate cooling is sufficient.

When the "Default" button is pressed, it sets the cooling temperature back to the default setting.



## camRAM

The camRAM tab gives control of three available memory segments of "camRAM", the camera's built in memory.



Although the camera has four memory segments, only three of them are accessible with camware, because one very small memory segment is used for the live preview image handling. Therefore, nearly all camRAM space can be freely distributed between the three available memory segments.

## Activating a camRAM Segment

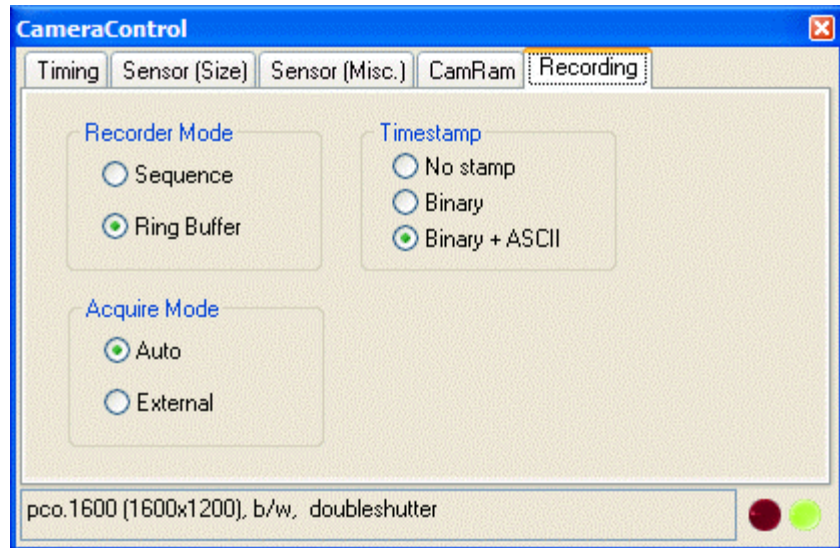
To activate a camRAM memory segment, use the radio buttons to make a selection. If a subsequent image recording is started, this segment will be used.

## camRAM Settings

The amount of memory for the active memory can be adjusted by using the number boxes, sliders (activated by pressing the arrow down buttons) or by clicking on one of the pie limiting lines and moving the mouse while holding the mouse button down. Neighboring memory segments will be adapted. The resulting memory sizes (in MB) are displayed in the status windows.

## Recording

The Recording sheet gives memory operation control (recorder mode), an additional external control signal (acquire mode) and an optional image integrated time stamp for better image sequence management.



### Recorder Mode

In sequence mode, the camera will stop after the active memory segment of the camRAM is filled once. The camRAM level indicator (see 5.24) displays the memory segment fill level. In ring buffer mode, the camera will record continuously into the memory segment. If the end of the segment is reached, the oldest images are overwritten, achieving a cyclical recording, until recording is stopped.

### Acquire Mode

The acquire mode enables or disables recording by an external static signal. If set to external, the camera will only record images if the external signal is valid and therefore enables recording.

### Timestamp

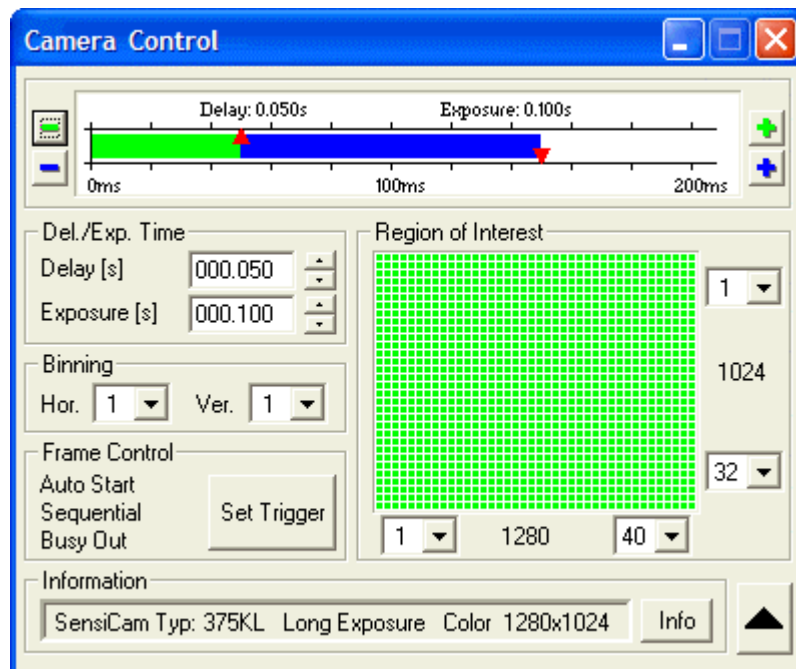
A timestamp can be placed into the upper left corner of each image. This option, which is selected using the radio buttons, includes: off, binary or binary with text.

In "binary mode", the first 16 pixels of each image will be filled with the time stamp. In "binary and ASCII" a timestamp text will be placed into the upper left corner of each image and, as such, the content of the image will be replaced by the text.

## 3.2 sensicam family



### 3.2.1 sensicam long exposure



#### Del./Exp. Time

The delay time ranges from 0 to 1000s and can be selected in steps of 1 [ms]. The green bar indicates the delay time. The mouse can be used to adjust the delay time by shifting the red arrowhead (up pointing) or by clicking on the green "+/-" symbols. Alternatively, it is possible to type the value into the number field beside "Delay [s]".

The exposure time ranges from 0 to 1000s and can be selected in steps of 1 [ms]. The blue bar indicates the exposure time. The mouse can be used to adjust the exposure time by shifting the red arrowhead (down pointing) or by clicking on the blue "+/-" symbols. Alternatively it is possible to type the value into the number field beside "Exposure [s]".

## Binning

A "super pixel" is formed when rows (vertically) and columns (horizontally) are combined. Please note, the resolution will be reduced and the frame rate will be increased (by vertical binning only).

Horizontal Binning: factor - 1, 2, 4, 8

Vertical Binning: factor - 1, 2, 4, 8, 16, 32

## Region of Interest (ROI)

The ROI selects only a part of the total CCD image sensor to be read out. The minimum is 32 pixels x 32 pixels. The area can be adjusted either by using the mouse, clicking into the ROI field and drawing an appropriate rectangle, or by selecting values from the drop down lists to determine the corner points. For another method see section 7.2.

The unused lines will be read out approximately four times faster, thus increasing the frame rate, while decreasing the amount of image data.

## Analog Gain

A normal and a high gain (-6dB) setting are available. This influences the integrated gain and the conversion factor, which describes how many charges are necessary to generate one count in the digital image. The higher gain is only useful if the camera is operated in binning mode

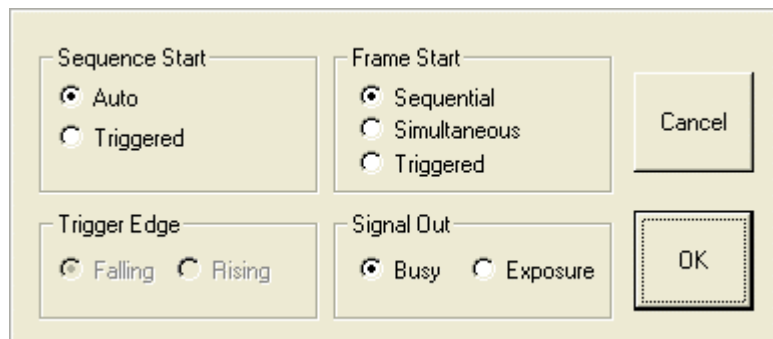
## Info

This status window gives information about the connected camera, including type of sensicam (this code is important in case of support questions), sensor type (b/w, color, VGA, SVGA), CCD- and electronics temperature, delay- /exposure times, readout time, frame rate [fps], trigger options. The information can be reviewed by pressing the "Info" button.

## Frame Control

### Set Trigger

The "Set Trigger" button opens an additional window, where the different trigger modes of the camera system can be selected:



### Sequence Start

The image recording sequence is either started internally - "Auto" or by an additional external trigger signal - "Triggered" at the BNC socket of the PCI frame grabber board.

### Frame Start

The image recording or exposure will be started in "Sequential" or "Simultaneous" mode or by an external trigger signal "Triggered". For more detailed information on triggering, please see the camera system manual.

### Trigger Edge

The user may select a rising or falling (trailing) edge to represent the external trigger signal.

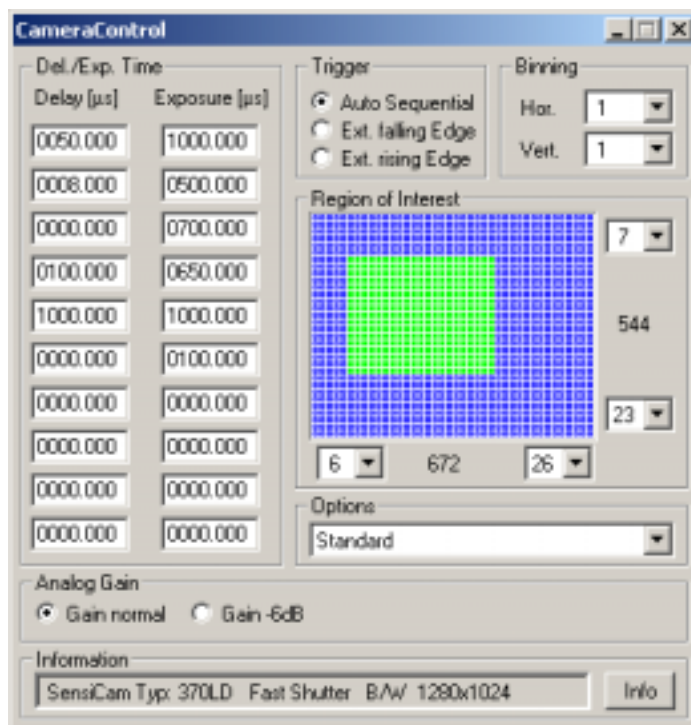
### Signal Out

The BNC socket at the frame grabber PCI board can also be used as an output channel. For more information on output signals, please see the camera system manual.

## 3.2.2 sensicam fast shutter

The sensicam fast shutter can be operated in standard mode and in a fast cycle mode. The desired mode can be selected from the drop down list "Options". Each mode has its own camera control window.

### sensicam fast shutter - standard mode



### Del./Exp. Time

Delay times range from 0 to 1ms and are selectable in steps of 100 [ns]. To enter and adjust the values, select the corresponding number field and type in the value.

Exposure times range from 100ns to 1ms and are selectable in steps of 100 [ns]. To enter and adjust the values, select the corresponding number field and type in the value.

A maximum of 10 pairs (delay + exposure time) can be defined. If only a single exposure or less than 10 pairs are required, simply set the unused times to 0000.000.

### Multiple exposure operation example

Del./Exp. time	
Delay [μs]	Exposure [μs]
0020.000	0005.000
1000.000	0000.000
1000.000	1000.000
0001.000	1000.000
0000.000	0100.000
0000.000	0000.000
0000.000	0000.000
0000.000	0000.000
0000.000	0000.000
0000.000	0000.000

Exposure 1: delay 20μs - exposure 5μs

Exposure 2: delay 1ms - exposure 0

Exposure 3: delay 1ms - exposure 1ms

Exposure 4: delay 1μs - exposure 1ms

Exposure 5: delay 0 - exposure 100μs

### Hints & Notes

- For exposure 2, the exposure time has been set to 0. This results in a delay of 1ms.
- Exposure 4 has a true duration of 1.1ms, since the delay of exposure 5 is 0, i.e. exposure 5 follows directly exposure 4. This results in an exposure time larger than 1ms.

### Trigger

Here the trigger operation mode can be selected by these radio buttons. The image recording sequence can either be started internally - "Auto Sequential", which is only available in sensicam fast shutter "Standard Mode" or by an additional external trigger signal - "Ext. falling Edge" (means trailing edge)

---

or "Ext. rising Edge" at the BNC socket of the PCI frame grabber board.

#### Binning

A "super pixel" is generated when rows (vertically) and columns (horizontally) are combined. Please note, the resolution will be reduced and the frame rate will be increased (by vertical binning only).

Horizontal Binning: factor - 1, 2, 4, 8

Vertical Binning: factor - 1, 2, 4, 8, 16, 32

#### Region of Interest (ROI)

The ROI selects only a part of the total CCD image sensor to be read out. The minimum is 32 pixels x 32 pixels. The area can be adjusted either by using the mouse, clicking into the ROI field and drawing an appropriate rectangle, or by selecting values from the drop down lists to determine the corner points. For a further method see section 7.2.

The unused lines will be read out approximately four times faster thus increasing the frame rate, while the amount of image data is decreased.

#### Options

The sensicam fast shutter "Standard" mode or the "Fast Cycles" mode may be selected from the drop down list.

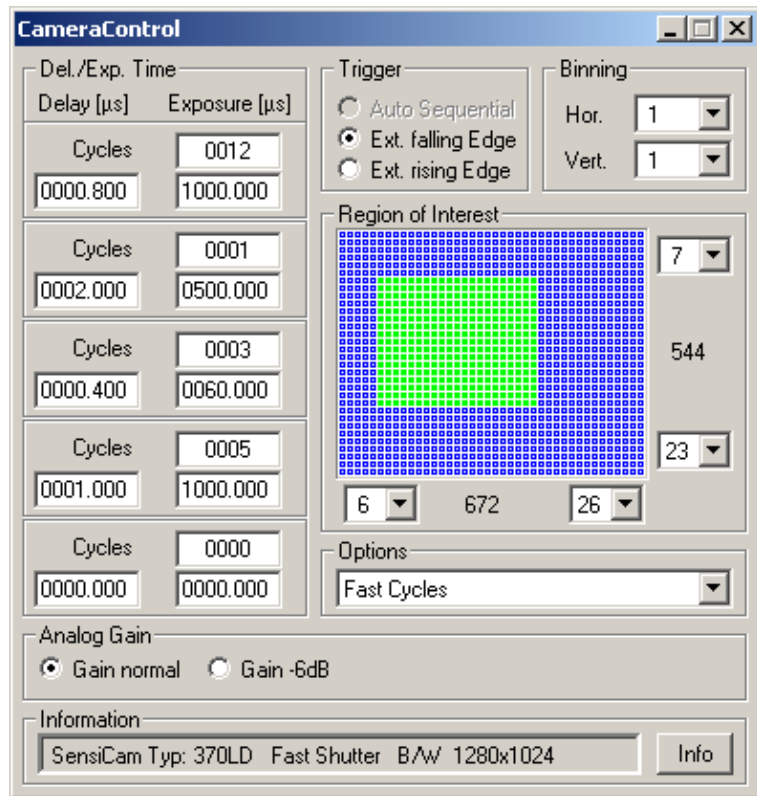
#### Analog Gain

A normal and a high gain (-6dB) setting are available. This influences the integrated gain and the conversion factor, which describes how many charges are necessary to generate one count in the digital image. The higher gain is only useful if the camera is operated in binning mode

#### Info

This status window gives information about the connected camera, including type of sensicam (this code is important in case of support questions), sensor type (b/w, color, VGA, SVGA), CCD and electronics temperature, delay- /exposure times, readout time, frame rate [fps] and trigger options. The information can be reviewed by pressing the "Info" button.

sensicam fast shutter - fast cycles mode



Del./Exp. Time

Delay times range from 0 to 1ms and are selectable in steps of 100 [ns]. To enter and adjust the values, select the corresponding number field and type in the value.

Exposure times range from 100ns to 1ms and are selectable in steps of 100 [ns]. To enter and adjust the values, select the corresponding number field and type in the value.

Within each cycle block, the corresponding delay + exposure time pair is repeated according to the cycle number, which can be typed in, if the corresponding number field is selected. Then the next cycle block begins. The cycles range from 0 to 1000. If the number of cycles is equal to 0, the block is ignored and skipped. A single delay + exposure time pair may not be smaller than 1μs.



Del./Exp. Time	
Delay [ $\mu$ s]	Exposure [ $\mu$ s]
Cycles: 0000.800	0012 1000.000
Cycles: 0002.000	0001 0500.000
Cycles: 0000.400	0003 0060.000
Cycles: 0001.000	0005 1000.000
Cycles: 0000.000	0000 0000.000

Exposure 1: delay - 800ns, exposure - 1ms, cycles - 12

Exposure 2: delay - 2 $\mu$ s, exposure - 500 $\mu$ s, cycles - 1

Exposure 3: delay - 400ns, exposure - 60 $\mu$ s, cycles - 3

Exposure 4: delay - 1 $\mu$ s, exposure - 1ms, cycles - 5

Exposure 5: delay - 0, exposure - 0, cycles - 0

#### Hints & Notes

- Each cycle must be triggered separately!
- At exposure 1, there are 12 exposures with an 800ns delay time and a 1ms exposure time for each.
- Then, there is one exposure with a delay of 2 $\mu$ s and an exposure time of 500 $\mu$ s.
- At exposure 3, there are 3 exposures with 400ns delay and 60 $\mu$ s exposure time.
- At exposure 4, there are 5 exposures with 1 $\mu$ s delay and 1ms exposure time.
- Finally, the last block is ignored since the cycle number is set to 0.

#### Trigger

The user may select the trigger edge by using the radio buttons. The image recording sequence can be started by an additional external trigger signal - "Ext. falling Edge" (means trailing edge) or "Ext. rising Edge" at the BNC socket of the PCI frame grabber board.

#### Binning

A "super pixel" is generated when rows (vertically) and columns (horizontally) are combined. Please note, the resolution will be reduced and the frame rate will be increased (by vertical binning only).

Horizontal Binning: factor - 1, 2, 4, 8

Vertical Binning: factor - 1, 2, 4, 8, 16, 32

Region of Interest (ROI)

The ROI selects only a part of the total CCD image sensor to be read out. The minimum is 32 pixels x 32 pixels. The area can be adjusted either by using the mouse, clicking into the ROI field and drawing an appropriate rectangle, or by selecting values from the drop down lists to determine the corner points. For a further method see section 7.2.

The unused lines will be read out approximately four times faster thus increasing the frame rate, while the amount of image data is decreased.

Options

The sensicam fast shutter "Standard" mode or the "Fast Cycles" mode may be selected from the drop down list.

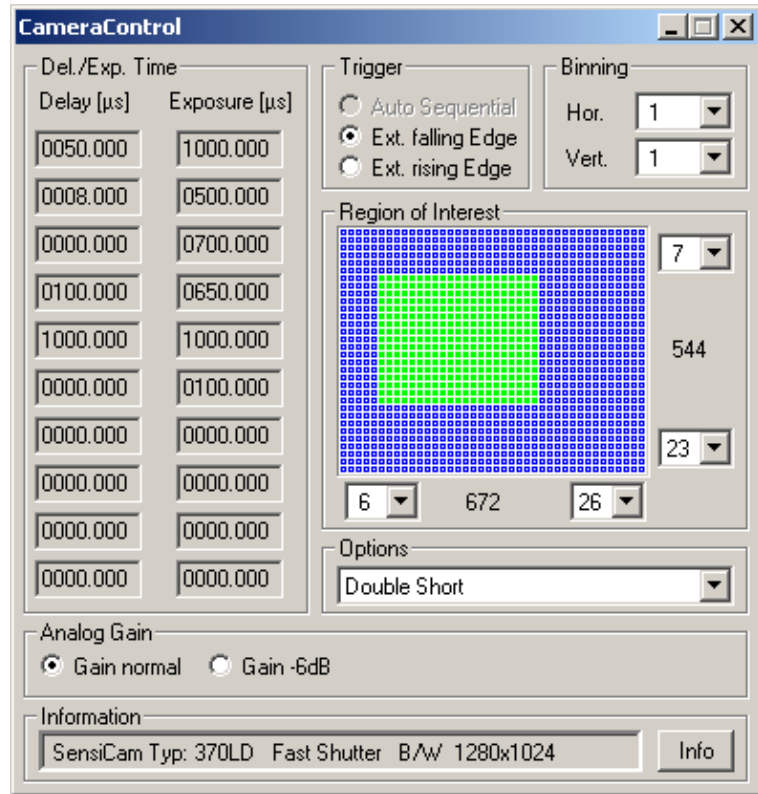
Analog Gain

A normal and a high gain (-6dB) setting are available. This influences the integrated gain and the conversion factor, which describes how many charges are necessary to generate one count in the digital image. The higher gain is only useful if the camera is operated in binning mode

Info

This status window gives information about the connected camera, including type of sensicam (this code is important in case of support questions), sensor type (b/w, color, VGA, SVGA), CCD- and electronics temperature, delay- /exposure times, readout time, frame rate [fps] and trigger options. The information can be reviewed by pressing the "Info" button.

### 3.2.3 sensicam double shutter



#### Del./Exp. Time

With the sensicam double shutter, the delay and exposure time settings are not accessible in the camera control window, so the corresponding input fields appear in gray color. The exposure time can only be controlled via external input signal, which must be supplied at the BNC socket [TRIG IN] at the frame grabber PCI board.

For more detailed information on the [TRIG IN] input, please see the sensicam double shutter / sensicam qe double shutter manual.

#### Trigger

The user may select the trigger edge by using the radio buttons. The image recording sequence can be started by an additional external trigger signal - "Ext. falling Edge" (means trailing edge) or "Ext. rising Edge" at the BNC socket of the PCI frame grabber board.

#### Binning

A "super pixel" is generated when rows (vertically) and columns (horizontally) are combined. Please note, the resolution will be reduced and the frame rate will be increased (by vertical binning only).

Horizontal Binning: factor - 1, 2, 4, 8

Vertical Binning: factor - 1, 2, 4, 8, 16, 32

Region of Interest (ROI)

The ROI selects only a part of the total CCD image sensor to be read out. The minimum is 32 pixels x 32 pixels. The area can be adjusted either by using the mouse, clicking into the ROI field and drawing an appropriate rectangle, or by selecting values from the drop down lists to determine the corner points. For a further method see section 7.2.

The unused lines will be read out approximately four times faster thus increasing the frame rate, while decreasing the amount of image data.

Options

This drop down list offers two double shutter operation modes:

- Double Short - dead time 200ns
- Double Long - dead time 1 $\mu$ s

and two fast shutter operations modes:

- Standard
- Fast Cycles

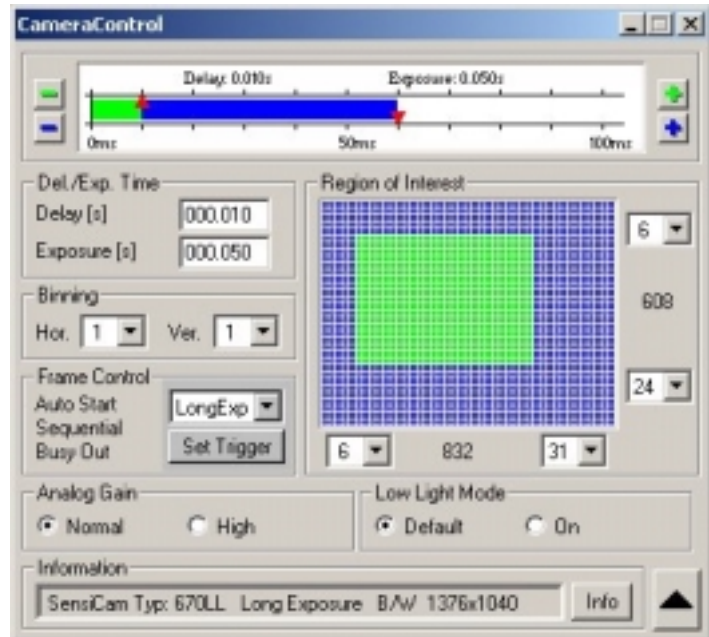
Analog Gain

A normal and a high gain (-6dB) setting are available. This influences the integrated gain and the conversion factor, which describes how many charges are necessary to generate one count in the digital image. The higher gain is only useful if the camera is operated in binning mode

Info

This status window gives information about the connected camera, including type of sensicam (this code is important in case of support questions), sensor type (b/w, color, VGA, SVGA), CCD- and electronics temperature, delay- /exposure times, readout time, frame rate [fps] and trigger options. The information can be reviewed by pressing the "Info" button.

## 3.2.4 sensicam qe



## Del./Exp. Time

The delay and exposure time range depends on the operation mode setting:

LongExp - The delay time ranges from 0 to 1000s and can be selected in steps of 1 [ms].

Fast - The delay time ranges from 0 to 10ms and can be selected in steps of 100 [ns].

The green bar indicates the delay time. The mouse can be used to adjust the delay time by shifting the red arrowhead (up pointing) or by clicking on the green "+/-" symbols. Alternatively it is possible to type the value into the number field beside "Delay [s]".

LongExp - The exposure time ranges from 1ms to 1000s and can be selected in steps of 1 [ms].

Fast - The exposure time ranges from 500ns to 10ms and can be selected in steps of 100 [ns].

Double - The exposure of two separate full frame images. It is controlled via the external trigger input signal at the frame grabber PCI board.

The blue bar indicates the exposure time. The mouse can be used to adjust the exposure time by shifting the red arrowhead (down pointing) or by clicking on the blue "+/-" symbols. Alternatively it is possible to type in the value into the number field beside "Exposure [s]".



The selection of the exposure time is internally generated in steps of 156.25ns. Therefore, the real value for short

exposure times represents only an approximation of the selected exposure time value.

## Binning

A "super pixel" is generated when rows (vertically) and columns (horizontally) are combined. Please note, the resolution will be reduced and the frame rate will be increased (by vertical binning only).

Horizontal Binning: factor - 1, 2, 4, 8

Vertical Binning: factor - 1, 2, 4, 8, 16

## Frame Control

Here operation and trigger modes can be selected.

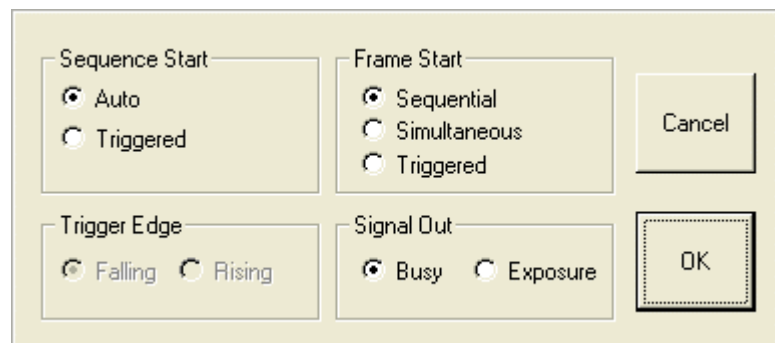
### Operation Mode

The dropdown list offers the selection of:

- LongExp - exposure time range: 1ms to 1000s
- Fast - exposure time range: 500ns to 10ms
- Double - double shutter exposure of 2 images

### Set Trigger

The "Set Trigger" button opens an additional window, where the different trigger modes of the camera system can be selected:



### Sequence Start

The image recording sequence is either started internally - "Auto" or by an additional external trigger signal - "Triggered" at the BNC socket of the PCI frame grabber board.

### Frame Start

The image recording or exposure will be started in "Sequential" or "Simultaneous" mode or by an external trigger signal "Triggered". For more detailed information on triggering, please see the camera system manual.

### Trigger Edge

The user may select a rising or falling (trailing) edge to represent the external trigger signal.

### Signal Out

The BNC socket at the frame grabber PCI board can also be used as an output channel. For more information on output signals, please see the camera system manual.

### Region of Interest (ROI)

The ROI selects only a part of the total CCD image sensor to be read out. The minimum is 32 pixels x 32 pixels. The area can be adjusted either by using the mouse, clicking into the ROI field and drawing an appropriate rectangle, or by selecting values from the drop down lists to determine the corner points. For a further method see section 7.2.

The unused lines will be read out approximately four times faster, increasing the frame rate, while decreasing the amount of image data.

### Analog Gain

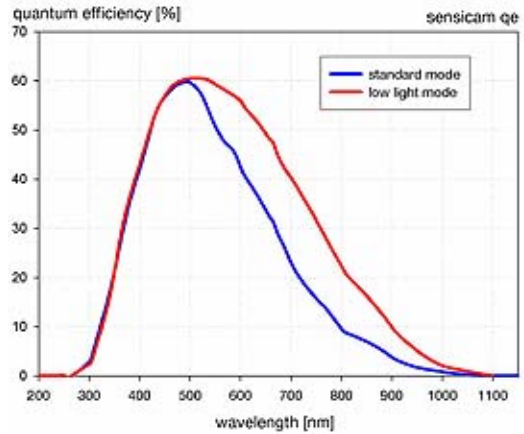
A normal and a high gain (-6dB) setting are available. This influences the integrated gain and the conversion factor, which describes how many charges are necessary to generate one count in the digital image. The higher gain is only useful if the camera is operated in binning mode

### Low Light Mode

Two modes can be selected, which differ in terms of camera system sensitivity in the near infrared and in anti-blooming performance.

Default (blue curve) - this is the standard light mode, which is useful for all exposure times up to 1000s. The anti-blooming performance is optimal.

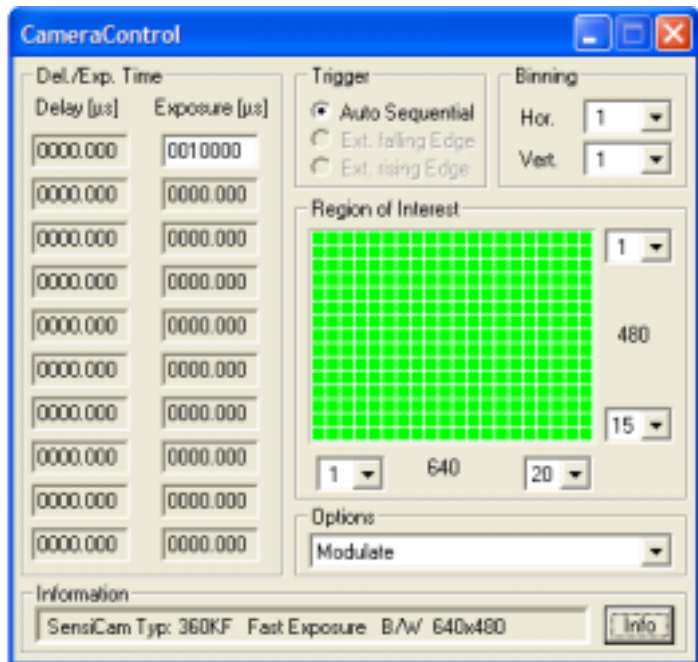
On (red curve) - this low light mode is useful for exposure times from 1ms - 1000s. The anti-blooming performance is reduced to a factor of four for over-exposure, but the sensitivity i.e. the quantum efficiency is maximized, as can be seen in the quantum efficiency curves below.



Info

This status window gives information about the connected camera, including type of sensicam (this code is important in case of support questions), sensor type (b/w, color, VGA, SVGA), CCD- and electronics temperature, delay- /exposure times, readout time, frame rate [fps], trigger options. The information can be reviewed by pressing the "Info" button.

3.2.5 sensicam sensimod



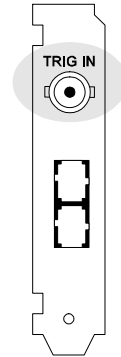
Del./Exp. Time

Only one exposure field is available in this mode. This field sets the integration time, during which modulation is accepted. So, it defines the master integration time window. The integration time ranges from 100µs to 1s in steps of 1 [µs].



The modulation signal must be connected via the BNC socket [MOD IN] at the rear panel of the camera.

The integration time window is available as an output signal via the BNC socket [TRIG IN] at the frame grabber PCI board. While this signal is HIGH, the camera will accept a modulation signal. Outside of this time window, any signal pulses, which are fed to the [MOD IN] input, will not generate any exposure or clearing processes. However, they may interfere with the CCD image sensor readout and cause distortions and disturbances. Therefore, these signals should be prevented.



PCI-Interface-Board

The BNC socket [TRIG IN] at the frame grabber PCI board only has output functionality for this camera system, and no input functionality.

#### [MOD IN]

The BNC socket [MOD IN] at the rear panel of the camera represents the input for external modulation signals, based on TTL level. Therefore:

- 0V => exposure
- 5V => clear

The input itself is internally secured with a  $1\text{k}\Omega$  pull-down resistor, i.e. an exposure is made while no external signal is applied. The characteristic time conditions are:

- time off  $\geq 500\text{ns}$
- time on  $\geq 500\text{ns}$
- maximum frequency 1MHz

There is an intrinsic delay of approximately 30ns between the trigger signal at the [MOD IN] input and the optical reaction.

#### Trigger

Auto Sequential operation mode is only available for this camera model. It is directly triggered by the modulation input signal.

## Binning

A "super pixel" is generated when rows (vertically) and columns (horizontally) are combined. Please note, the resolution will be reduced and the frame rate will be increased (by vertical binning only).

Horizontal Binning: factor - 1, 2, 4, 8

Vertical Binning: factor - 1, 2, 4, 8, 16

## Region of Interest (ROI)

The ROI selects only a part of the total CCD image sensor to be read out. The minimum is 32 pixels x 32 pixels. The area can be adjusted either by using the mouse, clicking into the ROI field and drawing an appropriate rectangle, or by selecting values from the drop down lists to determine the corner points. For a further method see section 7.2.

The unused lines will be read out approximately four times faster thus increasing the frame rate, while decreasing the amount of image data.

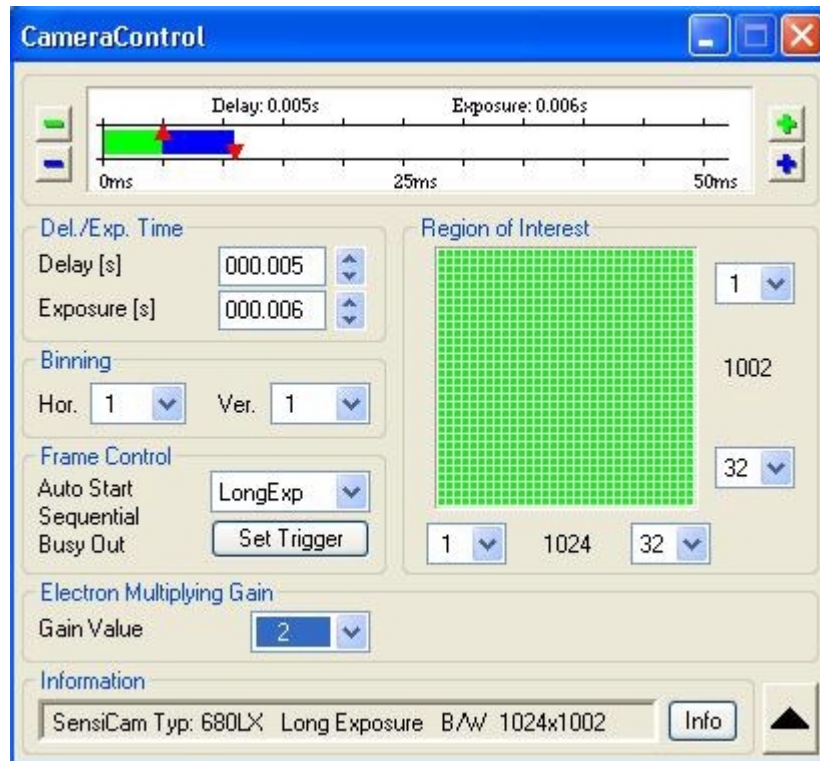
## Options

The "Modulate" option is only available here.

## Info

This status window gives information about the connected camera, including type of sensicam (this code is important in case of support questions), sensor type (b/w, color, VGA, SVGA), CCD- and electronics temperature, delay- /exposure times, readout time, frame rate [fps] and trigger options. The information can be reviewed by pressing the "Info" button.

## 3.2.6 sensicam em



## Del./Exp. Time

The delay and exposure time range depends on the operation mode setting:

LongExp - The delay time ranges from 0 to 3600s and can be selected in steps of 1 [ms].

Fast - The delay time ranges from 0 to 75ms and can be selected in steps of 75 [μs].

The green bar indicates the delay time. The mouse can be used to adjust the delay time by shifting the red arrowhead (up pointing) or by clicking on the green "+/-" symbols. Alternatively it is possible to type in the value into the number field beside "Delay [s]".

LongExp - The exposure time ranges from 1ms to 3600s and can be selected in steps of 1 [ms].

Fast - The exposure time ranges from 75μs to 15ms and can be selected in steps of 75 [μs].

The blue bar indicates the exposure time. The mouse can be used to adjust the exposure time by shifting the red arrowhead (down pointing) or by clicking on the blue "+/-" symbols. Alternatively it is possible to type the value into the number field beside "Exposure [s]".

## Binning

A "super pixel" is generated when rows (vertically) and columns (horizontally) are combined. Please note, the resolution will be reduced and the frame rate will be increased (by vertical binning only).

Horizontal Binning: factor - 1, 2, 4, 8

Vertical Binning: factor - 1, 2, (4, 8, 16, 32 for 992pixel resolution)

## Frame Control

Operation and trigger modes can be selected here.

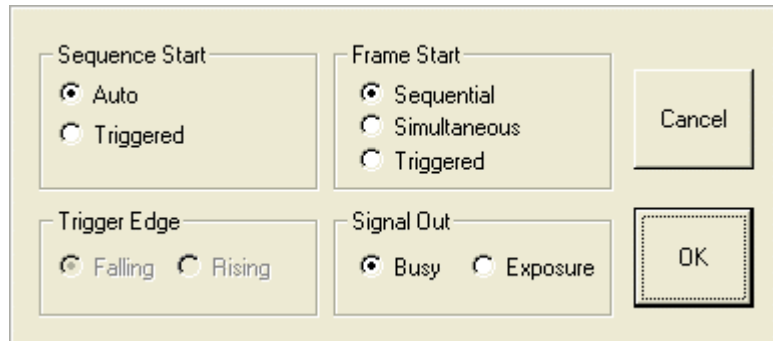
### Operation Mode

The drop down list offers the selection of:

- LongExp - exposure time range: 1ms to 3600s
- Fast - exposure time range: 75 $\mu$ s to 15ms

### Set Trigger

The "Set Trigger" button opens an additional window, where the different trigger modes of the camera system can be selected:



### Sequence Start

The image recording sequence is either started internally - "Auto" or by an additional external trigger signal - "Triggered" at the BNC socket of the PCI frame grabber board.

### Frame Start

The image recording or exposure will be started in "Sequential" or "Simultaneous" mode or by an external trigger signal "Triggered". For more detailed information on triggering, please see the camera system manual.

### Trigger Edge

The user may select a rising or falling (trailing) edge to represent the external trigger signal.

### Signal Out

The BNC socket at the frame grabber PCI board can also be used as an output channel. For more information on output signals, please see the camera system manual.

### Region of Interest (ROI)

The ROI selects only a part of the total CCD image sensor to be read out. The minimum is 32 pixels x 32 pixels. The area can be adjusted either by using the mouse, clicking into the ROI field and drawing an appropriate rectangle, or by selecting values from the drop down lists to determine the corner points. For a further method see section 7.2.

The unused lines will be read out approximately four times faster thus increasing the frame rate, while decreasing the amount of image data.

### Electron Multiplying Gain

The drop down list allows the user to set the electron multiplying gain of the emCCD image sensor. The following "Gain Values" can be selected:

x2, x5, x10, x20, x50, x100, x200, x500, x1000

It should be kept in mind, that with increasing gain, the existing photon noise in low-level signals is also amplified, while the readout noise stays constant.

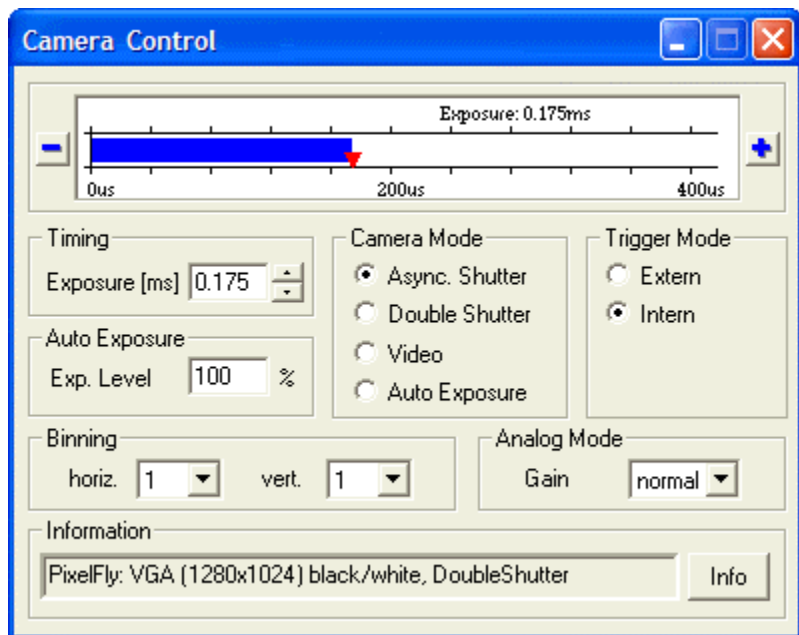
### Info

This status window gives information about the connected camera, including type of sensicam (this code is important in case of support questions), sensor type (b/w, color, VGA, SVGA), CCD- and electronics temperature, delay- /exposure times, readout time, frame rate [fps] and trigger options. The information can be reviewed by pressing the "Info" button.

### 3.3 pixelfly family



These are the camera control options for the pixelfly family.



#### Timing

The pixelfly's exposure time range depends on the camera mode selected:

- Async. Shutter: 10 $\mu$ s to 10ms, steps of 1 [ $\mu$ s]
- Double Shutter: 1ms to 10s, steps of 1[ms]
- Video: 10 $\mu$ s to 10ms, steps of 1[ $\mu$ s]

The blue bar indicates the exposure time. The mouse can be used to adjust the exposure time by shifting the red arrowhead (down pointing) or by clicking on the blue "+/-" symbols. It is also possible to type in value into the number field beside "Exposure [ms]".

#### Camera Mode

Each Camera Mode can be controlled by an automatic software trigger or by an external trigger signal (Trigger Mode).

When using asynchronous shutter (Async. Shutter), it is possible to set an exposure time ranging from 10 $\mu$ s up to 10ms. Only one exposure is started by an internal or external trigger signal. First the exposure occurs and afterwards the CCD image sensor is read out.

In doubleshutter mode (Double Shutter), two exposures will be released by a trigger signal. First, the exposure of the first image occurs, then, the first image will be read out. During the read out time of the first image, the second exposure is done. Then, the second image will be read out. The possible exposure times for the first double image range from 10 $\mu$ s up to 10ms.

In video mode, it is possible to adjust the exposure times from 1ms up to 10s. A sequence is started by the first trigger signal. No additional trigger signal is required. The exposure and the readout of the CCD will be done simultaneously.

In auto exposure mode, an exposure level must be set. This exposure level can range from 0% up to 255% (100% means full range - 4095). The exposure time is controlled automatically. Only one exposure will be released by a trigger signal.

#### Binning

A "super pixel" is generated when rows (vertically) and columns (horizontally) are combined. Please note, the resolution will be reduced and the frame rate will be increased (by vertical binning only).

Horizontal Binning: factor - 1, 2

Vertical Binning: factor - 1, 2 (VGA CCD image sensors 1, 2, 4)

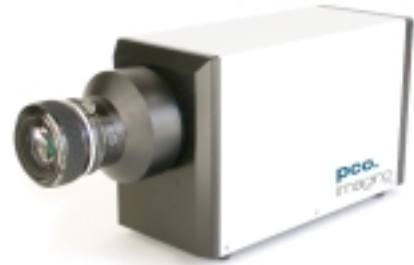
#### Analog Mode

In analog mode, a normal and a high gain (+6dB) setting are available. This influences the integrated gain and the conversion factor, which describes how many charges are necessary to generate one count in the digital image.

#### Info

This status window gives information about the connected camera, including type of pixelfly (this code is important in case of support questions), sensor type (b/w, color, VGA, SVGA), CCD- and electronics temperature, delay- /exposure times, readout time, frame rate [fps] and trigger options. The information can be reviewed by pressing the "Info" button.

## 3.4 dicam pro



## Single Trigger Mode

## Mode

Three operation modes are available on the drop down list: "Single Trigger", "Multi Trigger" and "Double Shutter".

In Single Trigger Mode, one delay and exposure time pair can be set, which is released with a single trigger. This can be repeated from 1 to 256 times, as chosen in the "Loops" field. After completing all the loops, one image is read out from the CCD image sensor. The minimum and maximum delay values and exposure times depend on the high voltage pulse unit, which is used in the camera. There are a variety of options available.



The trigger mode can be selected either for software trigger - "Auto" or external hardware trigger - "Extern". For detailed trigger information, please see the separate camera system manual.

### Phosphor/MCP

The phosphor "Decay" time of the image intensifiers phosphor screen is given in [ms]. Each phosphor has a specific decay time, depending on the applied dye material. This setting does not change the specific decay time of the integrated image intensifier, but it extends the integration time of the CCD image sensor.

Select the "Gain" by entering the "Gain [%]" field and typing in the value. The accepted values range from 0.0 to 100.0%. For optimal operation, the gain should be set at 80% to 100%. Using an intensifier gain of less than 50% is similar to the sensitivity already available in state of the art CCD camera systems.



The image intensifier is the most delicate and sensitive part of the entire camera system. Its lifetime is decisively influenced by the photocathode current (photo effect). The best way to preserve the photocathode is by setting a high Gain (in Phosphor/MCP Gain), as a small amount of input light generates a low photocathode current, but produces a high light output to achieve a high dynamic image on the CCD image sensor. The lifetime also depends on the number of exposures and the image intensifier's repetition rate.



If the image is overexposed, do not lower the image intensifier gain. Instead attenuate the light impinging on the photocathode by, e.g. closing the aperture or adding a neutral gray filter to the optical input.

### Del./Exp. Time

The delay and exposure time pairs can be adjusted by entering the appropriate values into the corresponding number fields.

- delay time range: 0 to 1000s
- exposure time range: 3ns to 1000s (the shortest exposure time depends on the camera system specifications)
- loop: 1 to 256



The delay and exposure time value are a combination of the values in the [ms] and the [ns] field.

### Binning

A "super pixel" is generated when rows (vertically) and columns (horizontally) are combined. Please note, the resolution will be reduced and the frame rate will be increased (by vertical binning only).

Horizontal Binning: factor - 1, 2, 4, 8

Vertical Binning: factor - 1, 2, 4, 8, 16, 32

Region of Interest (ROI)

The ROI selects only a part of the total CCD image sensor to be read out. The minimum is 32 pixels x 32 pixels. The area can be adjusted either by using the mouse, clicking into the ROI field and drawing an appropriate rectangle, or by selecting values from the drop down lists to determine the corner points. For a further method see section 7.2.

The unused lines will be read out approximately four times faster thus increasing the frame rate, while decreasing the amount of image data.

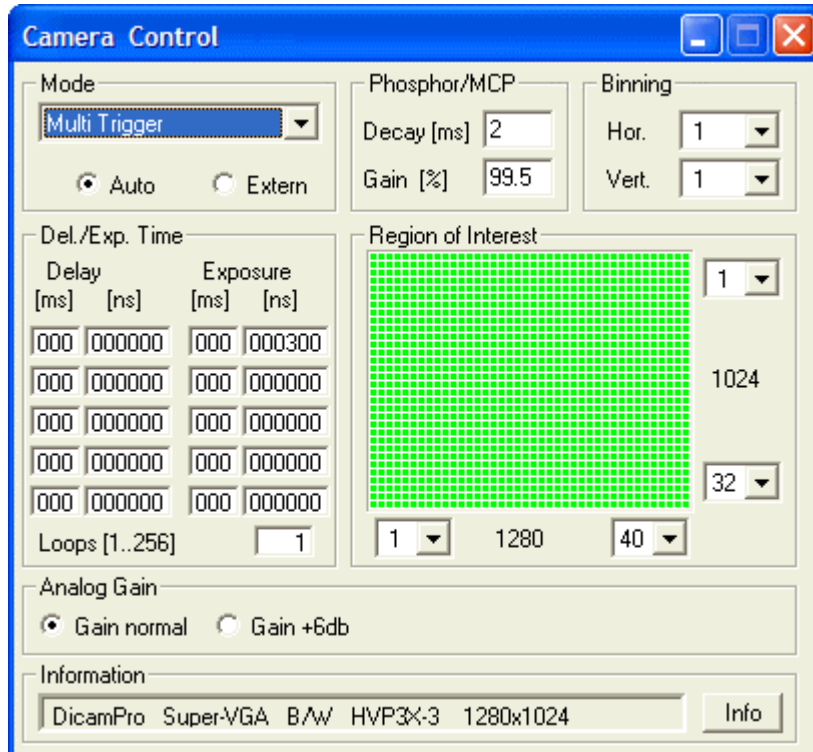
Analog Gain

A normal - "Gain normal" and a high gain "Gain +6dB" setting is available. This influences the integrated gain and therefore the conversion factor, which describes how many charges are necessary to generate one count in the digital image. The higher gain is only useful if the camera is operated in binning mode.

Info

This status window provides information about the connected camera, including type of dicam pro (this code is important in case of support questions), sensor type (b/w, VGA, SVGA), CCD- and electronics temperature, delay- /exposure times, readout time, frame rate [fps] and trigger options. The information can be reviewed by pressing the "Info" button.

## Multi Trigger



## Mode

The drop down list offers three operations modes: "Single Trigger", "Multi Trigger" and "Double Shutter".

In Multi Trigger Mode, it is possible to take multi exposures, each started with one trigger. This can be repeated from one to 256 times as chosen in the "Loops" field. After completing all the loops, one image is read out from the CCD. The minimum and maximum values of delay and exposure times depend on the high voltage pulse unit used in the camera system. There are a variety of options available.

The trigger mode can be selected either for software trigger - "Auto" or external hardware trigger - "Extern". For detailed trigger information, please see the separate camera system manual.

## Phosphor/MCP

The phosphor "Decay" time of the image intensifiers phosphor screen is given in [ms]. Each phosphor has a specific decay time, depending on the applied dye material. This setting does not change the specific decay time of the integrated image intensifier, but it extends the integrations time of the CCD image sensor.

To select the "Gain", enter the "Gain [%]" field and type in the desired value. The accepted values range from 0.0 to 100.0%. For optimal operation, the gain should be set at 80% to 100%. Using an intensifier gain of less than 50% is similar to the

sensitivity already available in state of the art CCD camera systems.



The image intensifier is the most delicate and sensitive part of the whole camera system. Its lifetime is decisively influenced by the photocathode current (photo effect). The best way to preserve the photocathode is by setting a high Gain (in Phosphor/MCP Gain), as a small amount of input light generates a low photocathode current, but produces a high light output to achieve a high dynamic image on the CCD image sensor. The lifetime also depends on the number of exposures and the intensifier's repetition rate.



If the image is overexposed, do not lower the image intensifier gain. Instead, attenuate the light incident on the photocathode by, e.g. closing the aperture or adding a neutral gray filter to the optical input.

#### Del./Exp. Time

The delay and exposure time pairs can be adjusted by entering the appropriate values into the corresponding number fields.

- delay time range: 0 to 1000s
- exposure time range: 3ns to 1000s (the shortest exposure time depends on the camera system specifications)
- loop: 1 to 256



The delay and exposure time value are a combination of the values in the [ms] and the [ns] field.

#### Binning

A "super pixel" is generated when rows (vertically) and columns (horizontally) are combined. Please note, the resolution will be reduced and the frame rate will be increased (by vertical binning only).

Horizontal Binning: factor - 1, 2, 4, 8

Vertical Binning: factor - 1, 2, 4, 8, 16, 32

#### Region of Interest (ROI)

The ROI selects only a part of the total CCD image sensor to be read out. The minimum is 32 pixels x 32 pixels. The area can be adjusted either by using the mouse, clicking into the ROI field and drawing an appropriate rectangle, or by selecting values from the drop down lists to determine the corner points. For a further method see section 7.2.

The unused lines will be read out approximately four times faster thus increasing the frame rate, while decreasing the amount of image data.

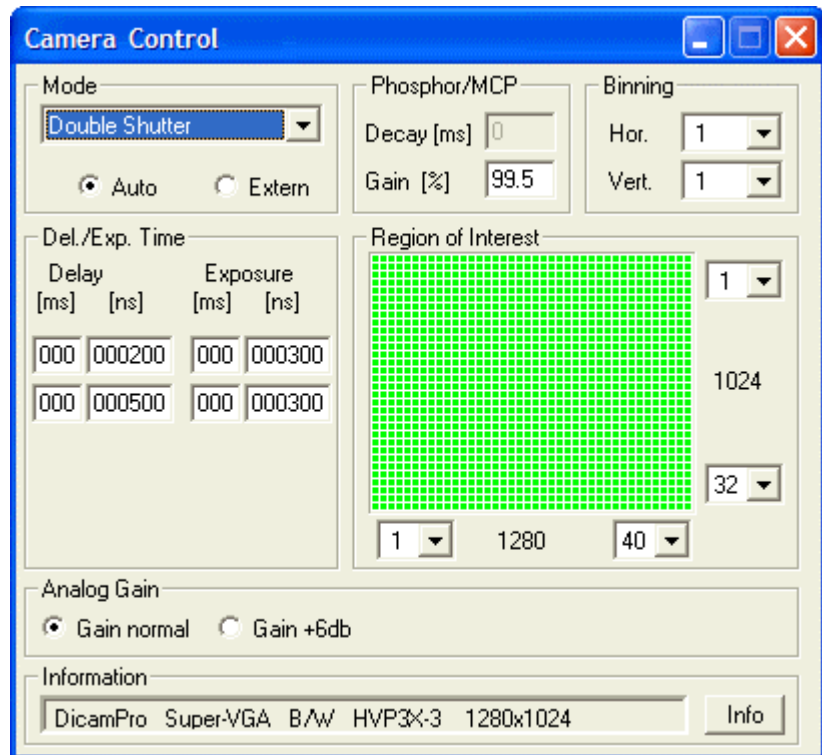
### Analog Gain

A normal - "Gain normal" and a high gain "Gain +6dB" setting is available. This influences the integrated gain and therefore the conversion factor, which describes how many charges are necessary to generate one count in the digital image. The higher gain is only useful if the camera is operated in binning mode.

### Info

This status window provides information about the connected camera, including type of dicam pro (this code is important in case of support questions), sensor type (b/w, VGA, SVGA), CCD- and electronics temperature, delay- /exposure times, readout time, frame rate [fps] and trigger options. The information can be reviewed by pressing the "Info" button.

## Double Shutter



## Mode

Three operations modes are available with the drop down list: "Single Trigger", "Multi Trigger" and "Double Shutter".

In "Double Shutter" mode, one trigger starts the exposure of two images (first image to A and second image to B). The minimum and maximum times of delay and exposure times depend on the high voltage pulse unit used in the camera.

## Phosphor/MCP

The phosphor "Decay" time of the image intensifier's phosphor screen is given in [ms]. Each phosphor has a specific decay time, depending on the applied dye material. This setting does not change the specific decay time of the integrated image intensifier, but it extends the CCD image sensor integration time.

To select the "Gain", enter the "Gain [%]" field and type in the desired value. The accepted values range from 0.0 to 100.0%. For optimal operation, the gain should be set at 80% to 100%. Using an intensifier gain of less than 50% is similar to the sensitivity already available in state of the art CCD camera systems.



The image intensifier is the most delicate and sensitive part of the entire camera system. Its lifetime is decisively influenced by the photocathode current (photo effect). The best way to preserve the photocathode is by setting a high Gain (in Phosphor/MCP Gain), as a small amount of input

light generates a low photocathode current, but produces a high light output to achieve a high dynamic image on the CCD image sensor. The lifetime also depends on the number of exposures and the intensifier's repetition rate.



If the image is overexposed, do not lower the image intensifier gain. Instead attenuate the light impinging on the photocathode by, e.g. closing the aperture or adding a neutral gray filter to the optical input.

#### Del./Exp. Time

The delay and exposure time pairs can be adjusted by entering the appropriate values into the corresponding number fields.

- delay time range: 0 to 1000s
- exposure time range: 3ns to 1000s (the shortest exposure time depends on the specifications of the camera system)



The delay and exposure time value are a combination of the values in the [ms] and the [ns] field.

#### Region of Interest (ROI)

The ROI selects only a part of the total CCD image sensor to be read out. The minimum is 32 pixels x 32 pixels. The area can be adjusted either by using the mouse, clicking into the ROI field and drawing an appropriate rectangle, or by selecting values from the drop down lists to determine the corner points. For a further method see section 7.2.

The unused lines will be read out approximately four times faster thus increasing the frame rate, while decreasing the amount of image data.

#### Analog Gain

A normal - "Gain normal" and a high gain "Gain +6dB" setting is available. This influences the integrated gain and the conversion factor, which describes how many charges are necessary to generate one count in the digital image. The higher gain is only useful if the camera is operated in binning mode.

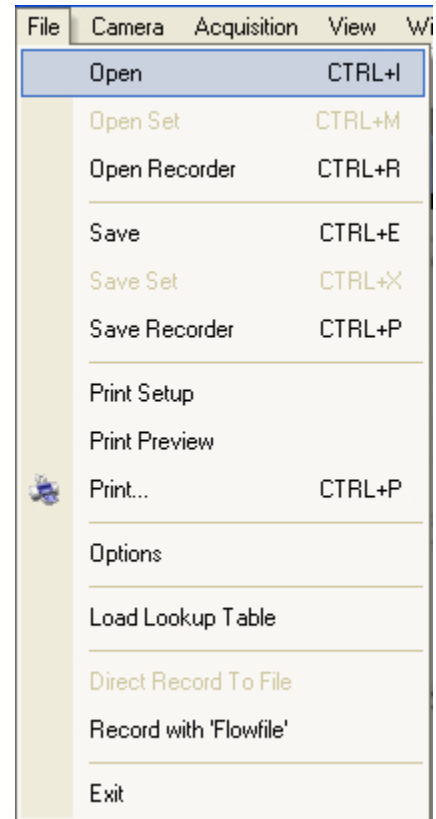
#### Info

This status window provides information about the connected camera, including type of dicam pro (this code is important in case of support questions), sensor type (b/w, VGA, SVGA), CCD- and electronics temperature, delay- /exposure times, readout time, frame rate [fps] and trigger options. The information can be reviewed by pressing the "Info" button.

## 4 Menu Bar

In this chapter, the functionality and commands of the different menus in the main menu bar are explained in detail.

### 4.1 Menu - File



#### 4.1.1 Open

This command should be used to import an image into the currently active image window. Only files with the extension and format of "\*.b16" and "\*.tif" can be imported (b16 - PCO proprietary binary image format, tif - TIFF image format). 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 sizes will be set to the parameters of the imported image.

#### 4.1.2 Open Set

The "Open Set" command should be used to import a set of images. The corresponding windows will be opened automatically. A comment window will also be opened, showing the camera settings with a comment. This command opens the "Open file" dialog box. Only files with the extension "\*.set" can



be imported. The filename of the images is generated by using the following convention: set name plus a number and the extension `"*.b16"`.

In "recorder mode", the "Open Set" command is automatically disabled.

#### 4.1.3 Open Recorder

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 window that has received the input focus (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"` and `"*.tif"` (TIFF16) can be imported.

#### 4.1.4 Save

The "Save" command should be used to save or export the image, which is displayed in the active window. The command opens the "Save file" dialog box. The image file can only be saved in `"*.b16"`, `"*.fts"`, `"*.tif"`, `"*.bmp"` or ASCII format.

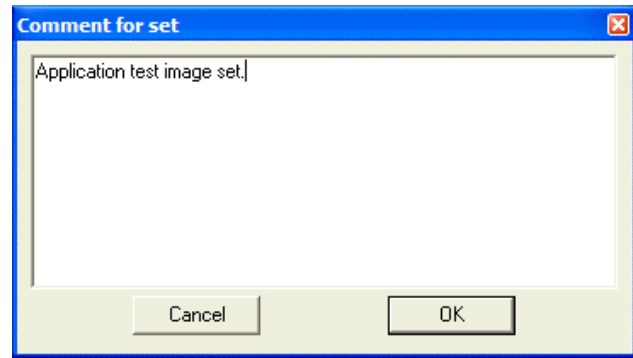
Note: be aware of the different storage abilities of the formats, for example `"*.bmp"` - the bitmap format only allows for 8bit values to be stored and therefore the image content of a 12 or 14bit image is reduced, if stored as bitmap.

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. With this feature it is possible 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 there is no image window open.

#### 4.1.5 Save Set

The "Save Set" command should be used to save or export the image, which is displayed in the currently active window. The command opens the "Save file" dialog box. The image file can only be saved in `"*.b16"` format. The naming convention is: image file name = set name plus a number and the `"*.b16"` extension. After the "Save file" dialog, the user will be prompted to type in a comment (experimental conditions or the like) if desired.



This comment is added to the information text file, which includes the actual camera settings. Later, if the set is opened again for processing purposes or the like, a text window is displayed which shows all the mentioned information including the comment.

If the recorder has been previously enabled, the "Save Set" command is not available. The "Save Set" command will not be available, if there is no image window open.

#### 4.1.6 Save Recorder

The "Save Recorder" command should be used to save or export image records. 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 file" dialog box. If another image format than "\*.b16" or "\*.tif" (16bit) is chosen, image content will be lost, and it will be impossible to reload the images.

The "Save Recorder" command will not be available, if there is no image window open.

#### 4.1.7 Print Setup

The "Print Setup" command opens the Windows "Print Setup" dialog box for adjustments and settings of the connected printer(s).

#### 4.1.8 Print Preview

The "Print Preview" command opens a "Print Preview" window.

#### 4.1.9 Print...

The "Print" command should be used to begin printing the currently displayed image or comment display (if activated). When there are no image windows open and no comment windows open, the printout will not be started. The command opens the Windows "Print" dialog box, where options such as number of copies, destination printer and other options can be

selected. The printout will be formatted as specified by the "Print Setup" (see section 4.1.7).

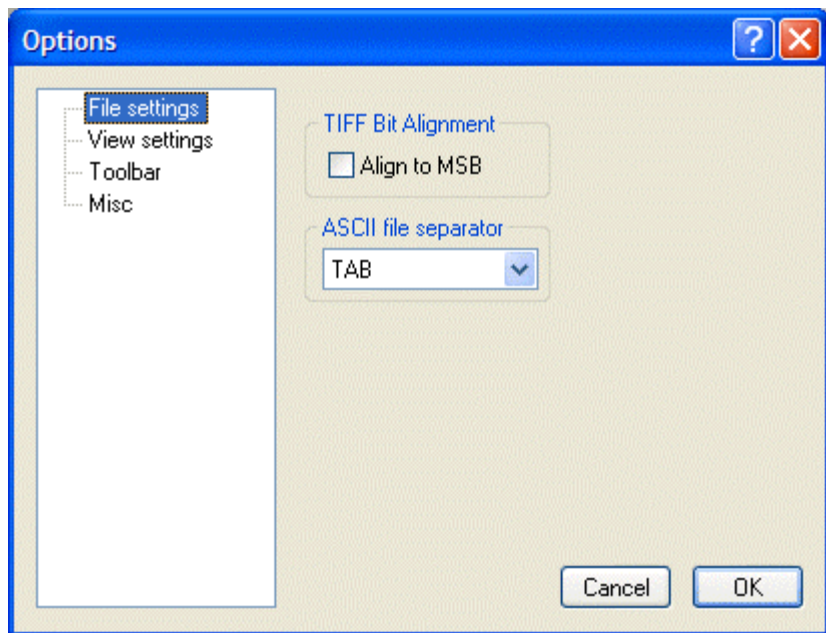


Shortcut: Toolbar - Button

#### 4.1.10 Options

This command opens the "Options" dialog, allowing special settings.

Options - File settings



##### TIFF Bit Alignment - Align to MSB

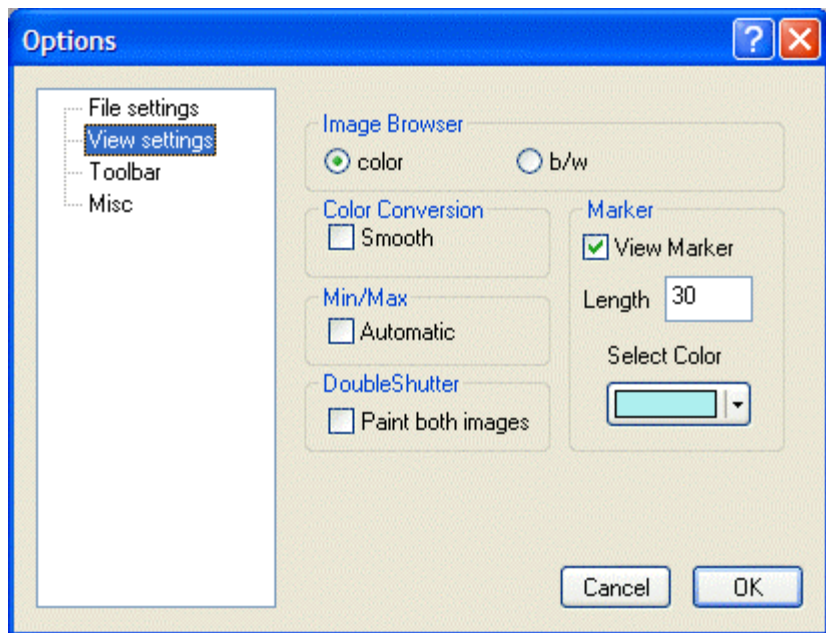
The alignment of the pixel values can be selected here. If the item is checked off, each pixel value is, for example, shifted from bit 12 - 1 to bit16 - 5. This removes the "dark image effect" inside other image processing and displaying applications. Check the item, if the camware-generated tiff-files should be used by other applications.

Users should note that the alignment is a binary shift operation and is not performing a scaling operation!

##### ASCII file separator

The drop down list allows the user to select the appropriate separator for the image storage in ASCII format.

## Options - View Settings



## Image Browser - color or b/w

The user can select whether all of the image tiles inside the browser window are displayed in either black/white or in color. The b/w setting results in a faster screen refresh. This feature is only available for cameras with a color CCD image sensor.

## Color Conversion - Smooth

If the "Smooth" option is checked off, an alternative color conversion algorithm is used. In default mode (box unchecked), the color is calculated with minimum averaging, resulting in images with high sharpness. If a smoother image with "softer" edges is required, this item should be selected by checking the box. When the user exits camware, the "Color Conversion" settings are saved and become the default settings for the next time camware is used.

This feature is only available for cameras with color CCD image sensors.

## Marker - View Marker, Length, Select Color

When "View Marker" is checked off, a crosshair is displayed in the active window in the center of each image.

Length - The user may select the length of the crosshair [in pixels].

Select color - This command opens a dialog box to allow changes to the crosshair color. The appropriate color can be selected by clicking on the desired color field. Once this is done, the selection must be confirmed by clicking the OK button.

## Min/Max - Automatic

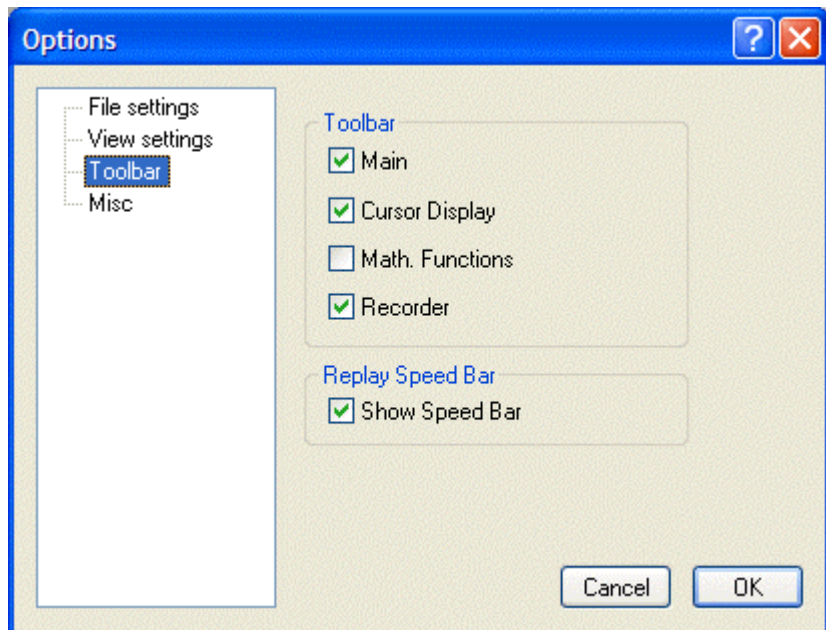
This option activates an automatic Min/Max scaling of the displayed images during record and replay.

This feature should be disabled if there are problems with the camware response when the automatic scaling is enabled (due to operating system capacity problems).

## DoubleShutter - Paint both images

If checked, this option enables the update of both double shutter/exposure images during record and replay. The checkbox should be disabled if camware is not responding to user interactions in this mode.

## Options - Toolbar



Toolbar - Main, Cursor Display, Math. Functions, Recorder

If "Main" is checked, the main toolbar is visible and accessible in camware.



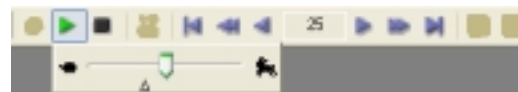
If "Cursor Display" is checked, the cursor readout window is displayed and updated. This cursor window shows the position and intensity value of the cursor at the particular point in the image.

If "Math. Functions" is checked, the mathematics tool window will be displayed.



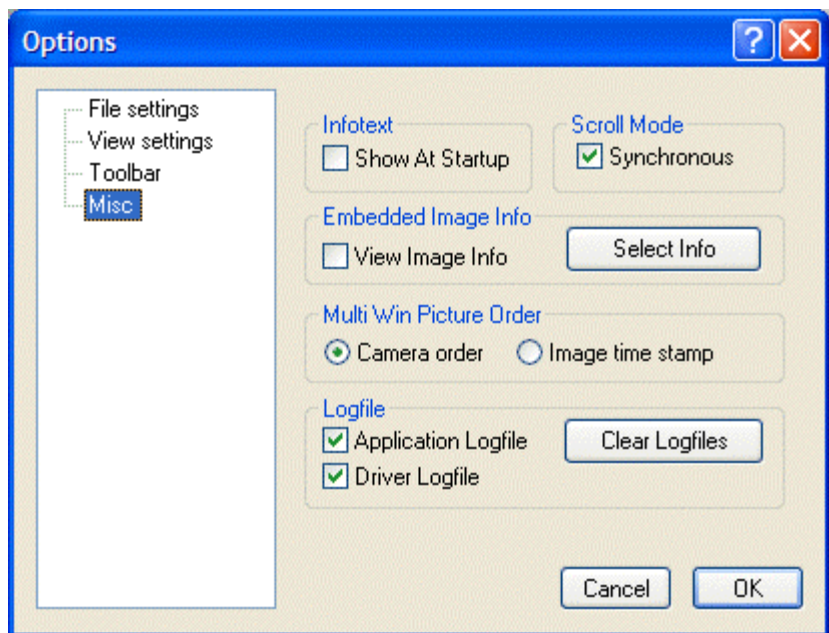
With the "Math. Functions" feature, it is possible to continuously calculate and display the difference between a reference image and the actual image. If the "Math. Functions" feature is activated, every new image will be subtracted from the reference image or vice versa. Math can be activated by pressing the "R" button (last acquired image will be copied to the reference buffer and taken as reference) or the "Flash-R" button (a reference image will be acquired). To avoid negative values, which would not be visible, it is possible to add an offset. If "Math. Functions" are enabled, a toolbar button with a green checkmark will be visible. By pressing the green checkmark the "Math. Functions" can be disabled, but the corresponding toolbar remains visible. If the "Math. Functions" are disabled, but they had previously been enabled, a toolbar button with a red cross is displayed. By pressing the red cross button, the "Math. Functions" can be enabled again.

Replay Speed Bar - Show Speed Bar



A replay speed bar feature may be selected, which is displayed just below the replay control buttons. The speed bar allows the user to adjust the replay speed, from very slow (turtle) to very fast (rabbit). The faster replay speed is useful if large sets of image data need to be scanned.

Options - Misc



### Infotext - Show At Startup

If the "Show At Startup" box is checked, the startup information dialog box will be displayed, when camware is started.

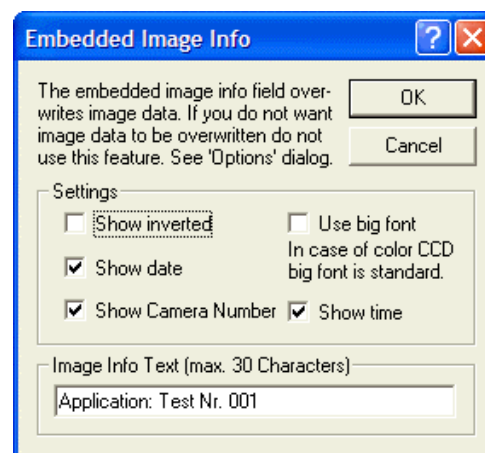
### Scroll Mode - Synchronous

If "Scroll Mode" box is checked, all opened image windows are scrolled simultaneously and in the same way.

### Embedded Image Info - View Image Info, Select Info

If "View Image Info" is checked an embedded text will be shown inside the image window.

If the "Select Info" button is clicked, the following window opens:



Use this feature if a comment, and/or the time/date the image was acquired and/or the camera number needs to be stored as visible information on the image. The text will be placed directly into the image and will cover a part of the image. Since the information will be saved with the image in every format, it cannot be lost.

Only the large font can be used with a color camera. This is because each color pixel is the result of a calculation based on four base pixels. As the small font covers fewer base pixels, it would not be readable.

### Multi Win Picture Order - Camera order, Image time stamp

This option should be used to organise the images. The images can be displayed according to the camera order or according to the individual image time stamp (See chapter 4.1.30 Multi Window).

### Logfile - Application Logfile, Driver Logfile, Clear Logfiles

The "Application Logfile" and "Driver Logfile" options enable and disable error logging and system information. If you

experience performance problems, this feature should be activated in order to create a support file, which helps PCO to find a solution.

The Button "Clear Logfiles" deletes all information currently in the logfiles.

#### 4.1.11 Load Lookup Table

Using this command loads a lookup table. It offers a Pseudo Look-Up-Table feature. With the Pseudo LUT feature any LUT can be loaded with one of four different formats and the result is displayed in the image windows.

The formats

1. File extension "\*.LT1": a file with 768 binary values consisting of 256 x rgb rgb rgb rgb ... (r=red, g=green, b=blue).
2. File extension "\*.LT2": a file with 3x 256 binary values consisting of 256 x red followed by 256 x green followed by 256 x blue values.
3. File extension "\*.LT3": a file with 768 ASCII values consisting of 256 x rgb rgb rgb rgb ... (r=red, g=green, b=blue).
4. File extension "\*.LT4": a file with 3x 256 ASCII values consisting of 256 x red followed by 256 x green followed by 256 x blue.

Either the enclosed predefined LUTs or self-defined LUTs can be used for pseudo coloring.

#### 4.1.12 Direct Record To File

This command should be used to record images directly onto the computer's hard disk. The command opens the "Save file" dialog box. The user must set the number of images to be stored to the disk. If the camera captures images faster than the computer can write to the disk, images will be lost. Image display does not interfere with the record process. For current computers, an approximate rate of 4-5 frames per second (fps) is typical.

#### 4.1.13 Record with "Flowfile"

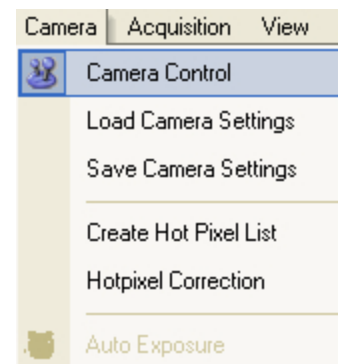
This command should be used to load a flow file. A flow file contains lines with a delay and an exposure time. Each line corresponds to one image to be acquired. If the flow file has 15 delay and exposure times then 15 images will be acquired. Before the image is snapped, the corresponding time values will be sent to the camera. This affects the possible image frame rate, as additional time is required for setting the values between two images. Please see the sample flow files in the application directory (e.g. flow.txt).



#### 4.1.14 Exit

Selecting the "Exit" command exits the program and closes all camera dialog windows. The PCI-interface-card (if present) and the camera will be reset. Window positions, settings and sizes are stored in the Windows registry and will be loaded again the next time camware is started.

### 4.2 Menu - Camera



#### 4.2.1 Camera Control

This command should be used to open the "Camera Control" window (See chapter 2).



Shortcut: Toolbar - Button

#### 4.2.2 Load Camera Settings

With this command, previously saved camera settings can be reloaded. The user can only open an image file that was made using the reloaded camera settings.

#### 4.2.3 Save Camera Settings

This command saves the actual camera settings of all present cameras, that have been recognized by camware.

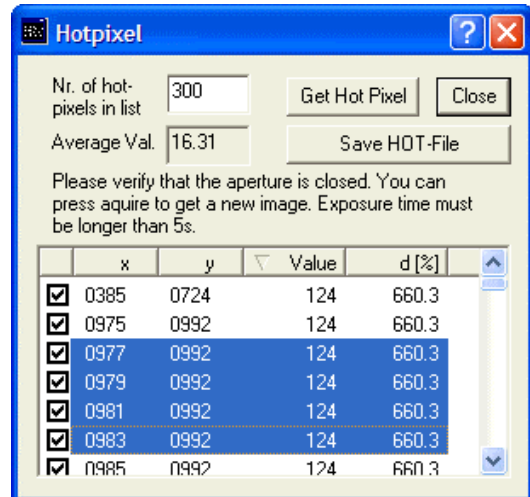
#### 4.2.4 Create Hot Pixel List

This command should be used to create a 'Hotpixel-List' in a file. Some pixels tend to become very bright during a long exposure. These pixels are called hotpixels. To remove hotpixels from the image, it is necessary to first create a hotpixel list in a file. If there has already been a hotpixel file created, the user only needs to enable the hotpixel correction feature.

The new replacement hotpixel value will be calculated by using an average of the neighboring pixel values.

A hotpixel list-file only can only be created if the last exposure time was longer than 5s.

The command opens the hotpixel list dialog box:

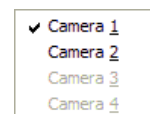


The user must first define and type in the desired amount of acceptable hotpixels. Then the "Get Hotpixel" button has to be pressed. Afterwards, the hotpixel list will be created, using the last acquired image.

Now, it is possible to save the hotpixel list for later use. All of the checkmarked list box items will be saved to the hotpixel list file. It is possible to select or deselect a group of items by highlighting the group and pressing the checkmark in front of one of the highlighted items. A local menu can also be opened inside the list box by pressing the right mouse button. The selection can be verified by scrolling through the list and compare it to the average value shown in the dialog box.

#### 4.2.5 Hot Pixel Correction

Using this command, the hotpixel correction feature can be enabled or disabled. If hotpixel correction has been previously disabled, an "Open File" dialog will be opened, in which the appropriate hotpixel list file has to be selected for the corresponding camera. If more than one camera is connected, the appropriate camera number has to be selected in advance using the camera select window:



This item is not available if the hotpixel correction has already been enabled.

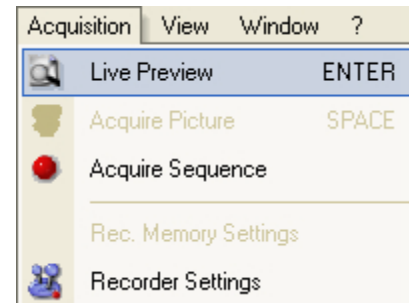
#### 4.2.6 Auto Exposure

The "Auto Exposure" command starts a couple of exposures and tries to figure out an exposure time, that records images with average intensity values between 34 to 36% of full scale. Once this has been achieved, the look up tables are adjusted for optimal display.



Shortcut: Toolbar - Button

#### 4.3 Menu - Acquisition



##### 4.3.1 Live Preview

The "Live Preview" is useful for fast and easy camera focus and adjustment. The active window will be updated. If another window needs to be opened, simply click on the window. The option is not available in double shutter mode.



Shortcut: Toolbar - Button, ENTER key

##### 4.3.2 Acquire Picture

The "Acquire Picture" command starts single image recording.



Shortcut: Toolbar - Button, SPACE bar

In case a pco.camera is connected, the position of this button has been moved to the recorder section of the main toolbar.



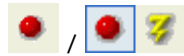
During recording, the camera controls are locked. It is possible to stop recording by selecting the "Acquire Picture" command again or by pressing the "ESC"-key.

##### 4.3.3 Acquire Sequence

When using a sensicam or pixelfly camera system the "Acquire Sequence" command starts recording images into the system

memory, beginning at buffer number "first image" (set in "setup recorder") up to buffer number "last image".

For a pco.camera system, the "Acquire Sequence" command starts recording images into the camera's built in memory (camRAM). During recording, the camera controls are locked. Before camera or converter settings can be changed, recording must be stopped.

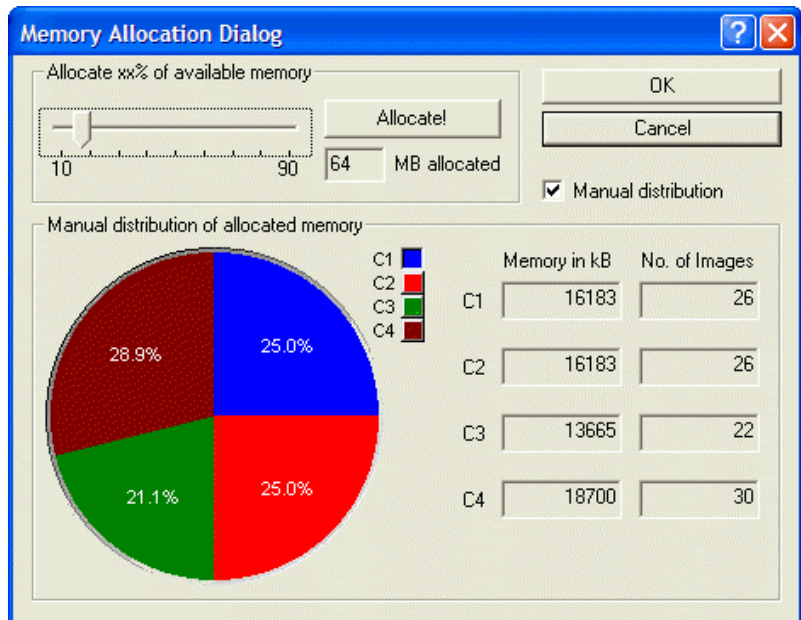


Shortcut: Toolbar - Button

#### 4.3.4 Rec. Memory Settings

This command should be used to open the recorder memory settings dialog window.

Memory Allocation Dialog for sensicam and pixelfly camera systems



Using this dialog box, the user can determine and adjust the amount of memory, which will be used for the recorder during runtime. Select the amount of memory (in %) and press the "Allocate" button. Use the "Manual distribution" feature if memory needs to be distributed according to user specified requirements. See section 6.1 (Memory and Speed) for further details.

If more than one camera is connected the memory can be distributed in two different ways:

Automatic

Uncheck the "Manual distribution" checkbox and the memory will be automatically distributed between the connected cameras. First the maximum equal image count is calculated. Second, the memory will be distributed according to the image resolution of each camera. In

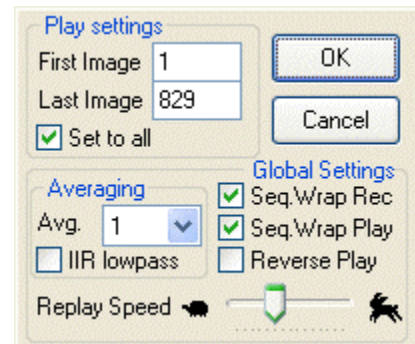
automatic mode the pie chart control is not accessible and the pies are displayed in grey.

#### Manual

Check the "Manual distribution" box. Now the memory can be distributed according to user requirements. In manual mode, the memory for each camera can be increased or decreased. This can be done by setting the input focus to the pie chart control and then either with the keyboard or with the mouse. Using the keyboard, select a camera by pressing the space bar. If the correct camera is selected, it is possible to move the complete pie with the left/right arrow keys. This function alters the memory for the clockwise next and previous camera. If the up/down keys are pressed, the memory for the selected camera is increased or decreased by changing the memory of the clockwise next camera. The same modifications can be done using the mouse, too. If one clicks on a pie chart it is possible to move the complete chart clockwise back and forward. If one clicks on a border line between two pie charts it is possible to move the border line. The modifications can be reviewed as amount of memory and the resulting count of images.

#### 4.3.5 Recorder Setup

This command should be used to open the Recorder Settings dialog window.



The "Camera Settings" are referred to a camera. If more than one camera is connected, the camera number is retrieved from the image window that has received the input focus (is active). If no image window is opened, the dialog is referred to camera 1. The first and last image can be set to which the recorder copies acquired images (with the pco.camera system this setting is only valid for replay). If the 'Set to all' checkbox is checked the settings apply to all connected cameras.

#### Global Settings

The "Global Settings" are valid for all connected cameras.

#### Averaging

If in the "Avg." dropdown list a value not equal to 1 is selected, the corresponding number of images is averaged in the buffer,

reducing the statistically independent noise. Another option to reduce the noise is the activation of the "IIR lowpass" IIR-filter.

$$\text{Image}(\text{act}) = \text{Image}(\text{act} - 1) * 0.5 + \text{Image}(\text{new}) * 0.5$$

#### Replay Speed Slider

The slider can be used to adjust the sequence replay speed, from slow (turtle) to fast (rabbit).

There are two possible image record and replay modes:

#### Sequence

Every single click onto the record/play button starts the exposures for the sequence defined in the first image/last image fields only one time. "Seq. Wrap Rec" and "Seq. Wrap Play" have to be unchecked for this mode.

#### Seq. Wrap Rec / Seq. Wrap Play

If "Seq. Wrap Rec" and "Seq. Wrap Play" are checked, the record/play button starts the exposures for a sequence as defined by the first image/last image fields and will loop until the stop button is pressed.

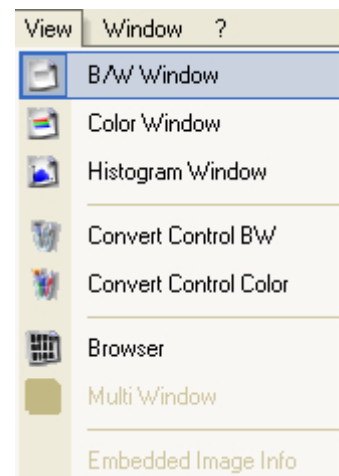
#### Reverse Play

If the "Reverse Play" box is checked, it is possible to play the recorded images in reverse.



Shortcut: Toolbar - Button

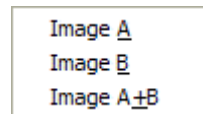
## 4.4 Menu - View



#### 4.4.1 B/W Window

This command should be used to open a b/w display window. If the camera is switched to "double shutter" trigger mode a popup-menu will be shown. In this menu the user may select either image A (first) or image B (second).

Select image A/B menu



This menu will appear if a b/w or color window is opened and the camera is set to double shutter. For each activated command, the user must select the executable image (A, B, A + B).

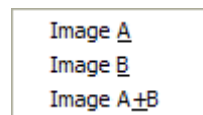


Shortcut: Toolbar - Button

#### 4.4.2 Color Window

This command should be used to open a color display window. If the camera is switched to "double shutter" trigger mode, a popup-menu will be shown. In this menu it is possible to select between image A (first) and image B (second).

Select image A/B menu



This menu will appear if a b/w or color window is opened and the camera is set to double shutter. For each activated command, the user must select the executable image (A, B, A + B).

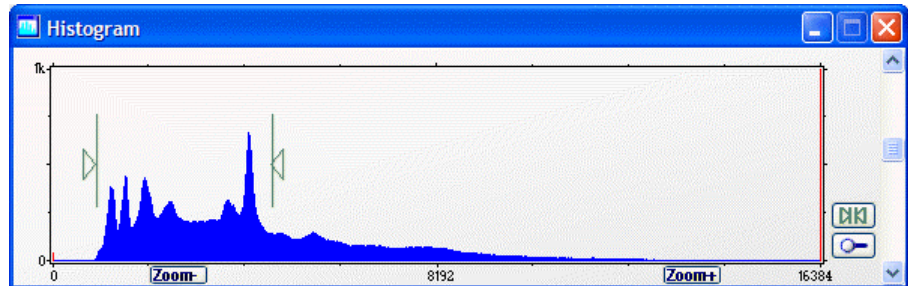


Shortcut: Toolbar – Button

## 4.4.3

## Histogram Window

This command should be used to open a histogram window.



The "Histogram Window" displays an intensity histogram of the current image. The amount of pixels is shown for each intensity value.

Two green lines with arrows also display the minimum and the maximum value of the "Convert Control Black/White". These two lines indicate which maximum dynamic intensity values [counts] are displayed in the 8 bit "Black/White Window" display. By clicking into the green triangle it is possible to change the minimum or maximum value of the "Convert Control B/W".

The zoom feature allows the user to zoom in the visible range to explore values in more detail. This can be done by pressing the "Zoom-", "Zoom+" buttons, or pressing the button with the two green arrows. Pressing the button with the two green arrows automatically zooms to the range spanned by the "min." and "max." "convert control" position. At this time, the "loupe" button gets pressed. If one wants to return to the complete range, the "loupe" button should be pressed. Release the "loupe" button to return to the zoomed view. If the histogram has been zoomed it is possible to scroll the range by clicking the area above the x-axis and moving it with the mouse.

The green lines, which represent the range of image values scaled to display, allow the user to visualize the affects of the two Auto Range functions (see below).

"Auto Range Peak" searches for the minimum and maximum intensity value of the image. Given these two values, the converter scales this range to the 8 bit display (256).

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

See chapter 4.1.8 "Auto Range Peak" and 4.1.9 "Auto Range Crop" for more information.

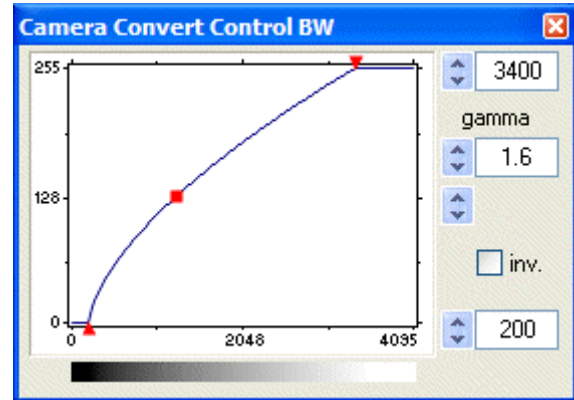


Shortcut: Toolbar - Button



#### 4.4.4 Convert Control BW

This command should be used to open the camera convert control b/w window.



The "Camera Convert Control B/W" consists of a diagram, which graphically displays the conversion method for the black/white image's maximum intensity values (x-axis) into 8 bit values (y-axis). The 8 bit value "0" corresponds to the 12 bit value at the left triangle. The 8 bit value "255" corresponds to the maximum value at the right triangle/arrowhead. Values, which are smaller than the left triangle, are displayed as black (0). Values, which are bigger than the right triangle, are displayed as white (255). The values in between are scaled into a grayscale value between "0" and "255". It is possible to manipulate the diagram by directly dragging the little arrowheads or square, by using the rocker switches or by directly typing the values into the text boxes. The result can also be seen in the form of a gray wedge at the bottom of the convert control window. Additionally it is possible to invert the conversion with the "inv." check box.

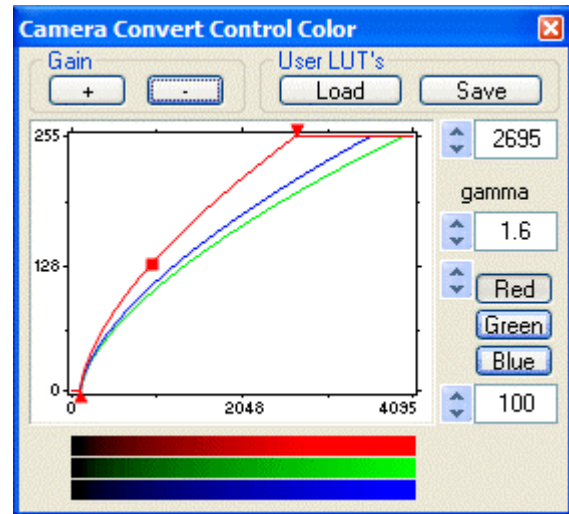
A gamma value can be set which enables the user to set a logarithmic or linear (if gamma is set to 1) conversion. The gamma value can be changed by right-clicking the red square or by directly editing the gamma text box. See the histogram 4.4.3 to understand the values at the left and right triangle.



Shortcut: Toolbar - Button

#### 4.4.5 Convert Control Color

This command should be used to open the camera convert control color window, which is accessible for all camera systems with color image sensors.



The most important feature of the "Camera Convert Control Color" is a diagram, which graphically displays the conversion method for the three colors (red, green and blue) from maximum intensity values (x-axis) into 8 bit values (y-axis). It is possible to manipulate the diagrams by selecting the color, and then dragging the little arrowheads or squares, using the rocker switches or by directly typing in the values in the text boxes. The color can be selected by clicking the corresponding button or by a mouse click on the upper end of the corresponding curve. The result can also be viewed in form of a color wedge at the bottom of the convert control window.

A gamma value can be set, which enables the user to set a logarithmic or linear (if gamma is set to 1) conversion. The gamma value can be changed by right-clicking the red square or directly by editing the value in the gamma text box.

A gain button allows the user to change the color specific gain (gradient of the graphs) to achieve a user manipulated white balance.

There is also an option to save and load lookup tables (LUT). There are various predefined LUTs for several color temperatures. These are selectable in the default LUT folder.



Shortcut: Toolbar - Button

#### 4.4.6 Recorder Browser

This command should be used to open the image browser window.

The "Recorder Browser" gives an overview of the existing recorded images and allows a new current image to be easily selected. The user simply clicks on the desired image to change the focus to this image (it becomes the active window). It may then be viewed in either the Black/White or Color Window, depending on the image sensor in the camera system.

The browser window can display up to 40 pictures. The user can easily print out the browser window page. If more than 40 pictures have been recorded, further pages are added. The user can switch between the single pages by double clicking inside the browser window or by using the local menu (right mouse button). Double-clicking into the upper half of the window will step one page back. Double-click into the lower half of the window will step one page forward. If the browser window is printed out, only the content that is actually displayed inside the window will be sent to the printer.



Shortcut: Toolbar - Button

#### 4.4.7 Multi Window

The "Multi Window" command should be used to open the multi frame window.

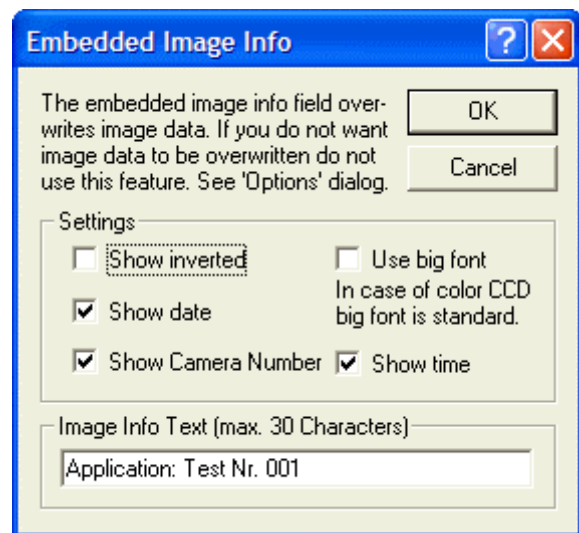
With the "Multi Frame Window" it is possible to view the images of all active cameras in one window. The user might select between 'time' oriented or 'camera number' oriented order. 'Time' oriented means that the image sequence depends on the individual time stamp of each image. 'Camera number' oriented means that the first image shown is from camera 1, then camera 2 and so on.



Shortcut: Toolbar - Button

#### 4.4.8 Embedded Image Info

If this item is checked, an embedded text will be shown inside the image. See Section 4.1.10 (Options - Misc.) for further information.

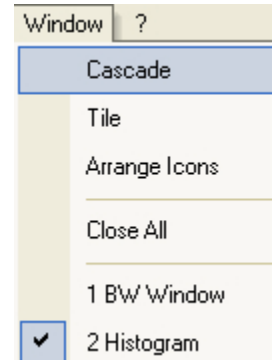


This feature should be used if a comment, and/or the time/date the image was acquired and/or the camera number should be

stored as visible information on the image. The text will be placed directly into the image and overwrites a part of the image. This information cannot be lost, because the information will be saved with the image in every format.

Only the large font can be used with a color camera. This is because each color pixel is the result of a calculation based on four base pixels. The small font is not readable, as it covers fewer base pixels.

## 4.5 Menu - Window



### 4.5.1 Cascade

The "Cascade" command displays all open image windows overlapped.

### 4.5.2 Tile

This command tiles all open image windows vertically or horizontally.

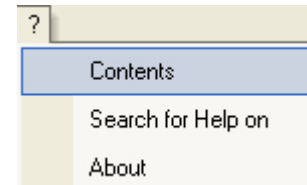
### 4.5.3 Arrange Icons

This command rearranges all minimized topic icons on the desktop.

### 4.5.4 Close All

This command closes all open image windows.

## 4.6 Menu - ?



### 4.6.1 Contents

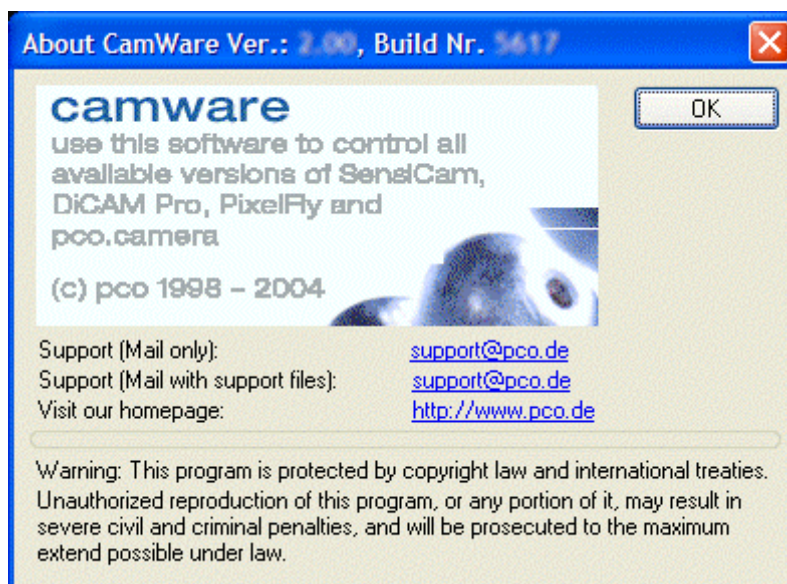
This command opens the main page of the online program help.

### 4.6.2 Search for Help on

This command opens a help index list.

### 4.6.3 About

This command opens an information window, and returns version information, which the user might send to PCO support via email with, or without service information.



This window shows some program information. By clicking the e-mail tag, the standard installed email program will be automatically started, conveniently allowing the user to write an email. In the event that a problem occurs with one of the PCO camera systems, support files may be generated, which will be automatically attached to the email. Those support files contain relevant hardware information, the logfiles and the PCO related registry entries. These files are moved into a zip-archive called CWSupport.zip, which can be found in the application folder. It is also possible to initiate the standard browser with PCO's website by clicking the homepage tag.

## 5 Buttons & Status Windows

The toolbar allows easy access to camera controls and dialogs.

Toolbar



Cursor readout window (top)

B/W x: 271 y: 167 Value:13925

Record and replay toolbar



### 5.1 Print Active Window



This button prints the currently displayed window (must be an image window or the comment window). See Section 4.1.9 (print) for further explanation.

### 5.2 View B/W



This button opens a b/w display window for the camera. See Section 4.4.1 (b/w window) for further explanation.

### 5.3 View Color



This button opens a color display window for the camera. See Section 4.4.2 (color window) for further explanation.

### 5.4 Open Histogram Window



This button opens the histogram window for the camera. See Section 4.4.3 (histogram window) for further explanation.

### 5.5 Camera Control



This button opens the camera control window. See Section 3 (camera control) for further explanation.

### 5.6 Convert Control B/W



This button opens the convert control b/w window. See Section 4.4.4 (convert control b/w) for further explanation.

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### 5.7 Convert Control Color



This button opens the convert control color window. See Section 4.4.5 (convert control color) for further explanation.

### 5.8 Auto Range Peak



This button forces camware to scale the 255 gray display levels to the minimum and maximum image intensity values of the image. See Section 4.4.3 (histogram window) for further explanation.

### 5.9 Auto Range Crop



This button forces camware to scale the 255 gray display levels to the minimum and maximum image intensity values of the image, while ignoring extreme intensities (dark or bright - like light spots, reflections, ...). See Section 4.4.3 (histogram window) for further explanation.

### 5.10 Auto Balance Color



This button activates the "auto balance color". The "White Balance" for color images is obtained by averaging the red pixels in the center of the image. The same method is used for the green and blue pixels in this area. Afterwards, the gain of the three colors is assimilated to get a gray level image. Thus one has to shoot (or import) an image with a white object in its center, e.g. a piece of white paper, before activating the "auto balance color" feature.

### 5.11 Auto Exposure



This button starts the camware auto exposure routine, which determines an optimum exposure time. See Section 4.2.6 (auto exposure) for further explanation.

### 5.12 Live Preview



The "live preview" button is useful for fast and easy camera adjustment and focusing. If active, live preview disables the camera control window. See Section 4.3.1 (live preview) for further explanation.

### 5.13 Acquire Picture



The "acquire picture" button records a single image. See Section 4.3.2 (acquire picture) for further explanation.

### 5.14 Master Gain +/- 2dB



These buttons change the scaling of the image intensity values for display and achieving therefore a virtual gain. The "+" button reduces the upper limit which represents 255

gray level (white), while the "-" button increases the lower limit which represents 0 gray level (black). See Section 4.4.4 (convert control) for further information.

### 5.15 Pixel Value

B/W x: 271 y: 167 Value:13925

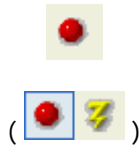
This toolbar window gives pixel position and intensity value information, where the cursor is pointing to in the active image window.

### 5.16 Continuous Auto Range



If selected the "continuous auto range" button performs an auto range crop type scaling for every image displayed. This applies to live preview, replay and recording modes. If the intensity between the images of a sequence changes, the limits of the conversion are adapted to display a well-balanced gray image continuously.

### 5.17 Start Record



This button starts recording images into the system memory. Recording begins at the buffer number "first image" (as previously set up in "setup recorder") up to the buffer number "last image". The camera controls are locked during recording. For a pco.camera, images will be recorded to the built-in camRAM. The pco.camera always starts recording with image number one. Always stop recording before changing camera or converter settings. If a "soft trigger" is selected (for a pco.camera) and the "start record" button is pressed, it is possible to start single software triggered images, while using the buttons shown in brackets.

### 5.18 Play Record



This button starts the image playback in the recorder beginning at buffer number "first image" set in "setup recorder", up to buffer number "last image". It is possible to control the playback speed with the slider described in Section 4.3.5 (recorder settings).

### 5.19 Stop Record



This buttons stops recording or playback activities.

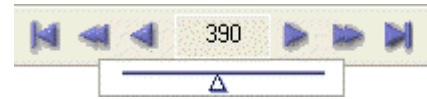
### 5.20 Setup Recorder



This button opens the recorder settings window, where various parameters can be adjusted, as described in Section 4.3.5 (recorder settings).



## 5.21 Replay Navigation



These recorder bar buttons and controls navigate the recorder and choose the image to be viewed.

Camware can record up to 9999 images! The ">" (forward) and "<" (rewind) buttons select the next and preceding image, respectively. The ">>" (fast forward) and "<<" (fast rewind) buttons switch multi images forward and rewind multi images, respectively (in 10 steps). The ">|" (last image) and "|<" (first image) buttons jump to the last and the first image, respectively.

If there are more than 50 recorded images, it is also possible to slide through the images by clicking and holding the left mouse button inside the image number edit control. Once inside the edit control, use the mouse wheel to step through images.

The status window gives the position number of the displayed image within the recorded sequence.

## 5.22 Image Browser



This button starts the "Recorder Browser", which giving an overview of the images in the recorder, and allows the user to easily select a new current image. The user simply clicks on the desired image to change the focus to this image (it becomes the active window). Then, it may be viewed in either the Black/White or Color Window, depending on the camera system image sensor.

The Browser window can show up to 40 pictures, allowing easy Browser window printing. If more than 40 images have been recorded, further pages are added. The user can switch between the individual pages by double clicking inside the Browser window or by using the local menu (right mouse button). Double-clicking into the upper half of the window will step one page back. Double-clicking into the lower half of the window will step one page forward. If the Browser window is printed out, only the content that is actually displayed inside the window will be sent to the printer.

## 5.23 Multi Window



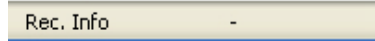
This button opens the multi frame window. With the "Multi Frame Window" it is possible to view all active camera images in one window. The user might select between "time" oriented or "camera number" oriented order. "Time" oriented means that the sequence of images depends on the individual time stamp of each image. "Camera number" oriented means that the first image shown is from camera 1, then camera 2 and so on.

### 5.24 camRAM Level Indicator



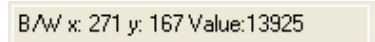
This status display shows the amount of the selected memory segment that has already been used, if images are recorded to the camRAM in the pco.camera systems.

### 5.25 Rec. Info



*Future feature: In future versions of camware, this status display will show the number of images, that can be recorded.*

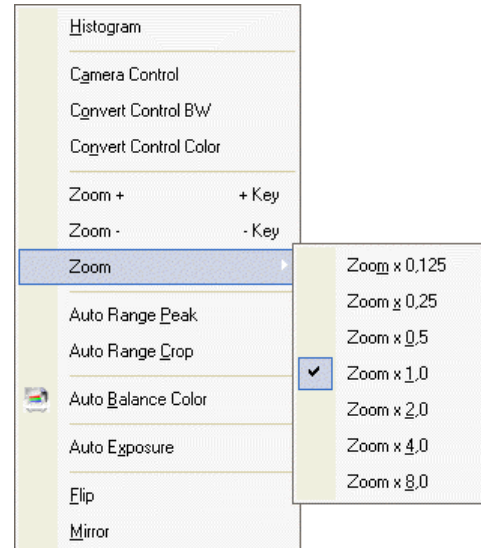
### 5.26 Cursor



This status display gives the same information as described in Section 5.15 (pixel value). For the selected pixel, it displays the pixel position and intensity value.

## 6 Local Menu - Right Mouse Button

If you right click the mouse on the image window, it opens up a local menu.



### 6.1 Histogram

This command opens the histogram windows, as described in Section 4.4.3.

### 6.2 Camera Control

This command opens the camera control window, as described in Section 3.

### 6.3 Convert Control BW

This command opens the convert control bw window, as described in Section 4.4.4.

### 6.4 Convert Control Color

This command opens the convert control bw window, as described in Section 4.4.5.

### 6.5 Zoom (+/-) - (+/--Key) - (x0.125..x8.0)

These commands change the zoom used to display the image. The image window size adapts to a smaller size automatically. Scrollbars will be shown, if the image is larger than the current window size. The current zoom factor is denoted by a checkmark.

### 6.6 Auto Range Peak

This command forces camware to scale the 255 gray levels for display to the minimum and maximum image intensity values. See Section 4.4.3 (histogram window) for further explanation.

### 6.7 Auto Range Crop

This command forces camware to scale the 255 gray levels for display to the minimum and maximum image intensity values, while ignoring extreme intensities (dark or bright - like light spots, reflections, ...). See Section 4.4.3 (histogram window) for further explanation.

### 6.8 Auto Balance Color

This command activates the "auto balance color". The "White Balance" for color images is obtained by averaging the red pixels in the center of the image. The same method is used for the green and blue pixels in this area. Afterwards, the gain of the three colors is assimilated to get a gray level image. Thus, one has to shoot (or import) an image with a white object in its center, e.g. a piece of white paper, before activating the "auto balance color" feature.

### 6.9 Auto Exposure

This command starts camware's "auto exposure" routine of camware, which determines an optimum exposure time. See Section 4.2.6 (auto exposure) for further explanation.

### 6.10 Flip

If this option is selected, the image will be flipped before it is shown in the image window. If this option is selected, a checkbox will appear to the left of the word in the menu. After exiting camware, this option is saved as default setting.

### 6.11 Mirror

If this option is selected, the image will be mirrored before it is shown in the image window. If this option is selected, a checkbox will appear to the left of the word in the menu. After exiting camware, this option is saved as default setting.

## 7 Additional Features

### 7.1 Setting Contrast Area by Mouse

The mouse can be used to control the min. and max. values, which are used to convert from maximum dynamic [bit] to 8 bit.

To accomplish this, move the mouse cursor into a region which should be displayed at maximum contrast. Then, simultaneously press the shift key and the left mouse button. Keep the mouse button down while increasing the size of the now displayed rubber-band window, which changes shape according to mouse movement. After releasing the mouse button, the the rubber-band window coordinates act as an ROI limit, which is used for the minimum / maximum determination when doing a proper scaling.

### 7.2 Setting a new ROI by Mouse

In the same manner, it is possible to select a new region of interest (see ROI in Section 3) for the camera.

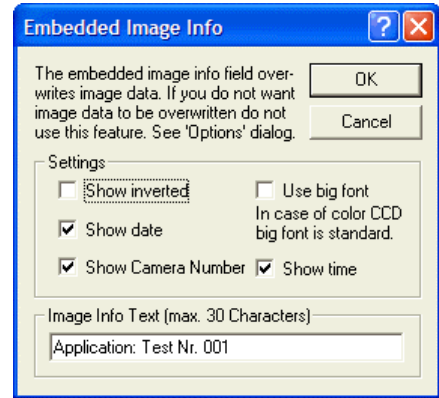
To accomplish this, move the mouse cursor into a region which should be used to define a ROI. Than, simultaneously press the CTRL (Strg) key and the left mouse button. Keep the mouse button down while increasing the size of the now displayed rubber-band window, which changes shape according to mouse movement. After releasing of the mouse button the rubber-band window coordinates are used to define a new region of interest (ROI). To reset the ROI to maximum, the user simply has to presses the CTRL (Strg) key and double clicks into the image window. This feature is not available for the pixelfly camera system.

### 7.3 Command Line Argument

If the user does not want the splash screen displayed at startup, "/nosplash" can be used as a command line argument.

### 7.4 Embedded Image Info

If this command is used, an embedded text will be shown inside the image (See Section 4.1.10 (Options - Misc.)).



This feature should be used if a comment, and/or the time/date the image was acquired and/or the camera number should be stored as visible information in the image. The text, directly placed into the image, will overwrite a part of the image. This information cannot be lost, as the information will be saved with the image in every format.

Only the large font can be used with a color camera. This is because each color pixel is the result of a calculation based on four base pixels. The small font covers fewer base pixels and is therefore not readable.

## 7.5 Time Elapse Window

If an image is recorded with an exposure time longer than 5s, a time elapse window will appear to show the remaining time of the current exposure.

## 8 Hints

### 8.1 Image File Formats

There are five available file formats for saving camera images with camware.

#### BMP

Windows Bitmap Format, b/w or color 8 bit format - images, which have been saved in BMP format can later only be loaded as 8 bit images, i.e. part of the original information (10bit, 12bit or 14bit) is lost.

#### TIFF

Tag Image Eile Format, version 6.0 and lower - there is a 16bit monochrome and color image format.

#### FTS

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

#### ASCII

16 bit format, some mathematical programs prefer ASCII data.

Listing of intensities (0...4095) of all pixels as follows:

x1 <TAB> x2 ... xn

x12

...

xm

(with n = number of columns = image width, m = number of lines = image height)

#### 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 16 bit pixel values represent "unsigned integer values", where the camera (12 bit values) sets the higher 4 bits to zero.

The file format consists either of a "Basic Header" (6 Long-parameter) or of 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 (4 ... 1280)
5	image height	image height in pixel (1 ... 2048)
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 (0 ... 4094)
9	b/w max	black/white LUT-setting, maximum value (1 ... 4095)
10	b/w linlog	black/white LUT-setting, linear respect. logarithmic, 0 = lin, 1 = log
11	red min	red LUT-setting, minimum value (0 ... 4094)
12	red max	red LUT-setting, maximum value (1 ... 4095)
13	green min	green LUT-setting, minimum value (0 ... 4094)
14	green max	green LUT-setting, maximum value (1 ... 4095)
15	blue min	blue LUT-setting, minimum value (0 ... 4094)
16	blue max	blue LUT-setting, maximum value (1 ... 4095)
17	color linlog	color LUT-setting, linear respect. logarithmic, 0 = lin, 1 = log
18 ... 255	internal use	
Comment file in ASCII characters with variable length of 0 ... XX. The length of the comment filed must be documented in the 'header length' field.		
		<b>16 bit pixel data</b>
line 1, pixel 1		value of the first pixel
line 1, pixel 2		value of the second pixel
...		...



We recommend that all images be saved (exported) first in the b16 or tiff (16 bit) format. The advantage is to have the b16 or tiff images available all the time. You will always have the maximum 12/14 bit information. Please note that not all image analysis programs can accomodate 16 bit data. The 8 bit format saves only the information displayed on the monitor screen. The 12/14 bit information will be lost and cannot be displayed later.



Dear Customer,

We hope that camware will be a valuable tool for your daily scientific work.

Your comments, suggestions or new ideas regarding our software and camera system are always welcome.

We are at your service and thank you for purchasing this camera and software.

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