

# DocuLUX

## USER MANUAL

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Title Page Image: Isolated Cardiomyocyte, cell contacted by a patch pipette; Courtesy of Prof. Peter Lipp, Institute for Molecular Cell Biology, Saarland University, Homburg, Germany

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# 1 Introduction

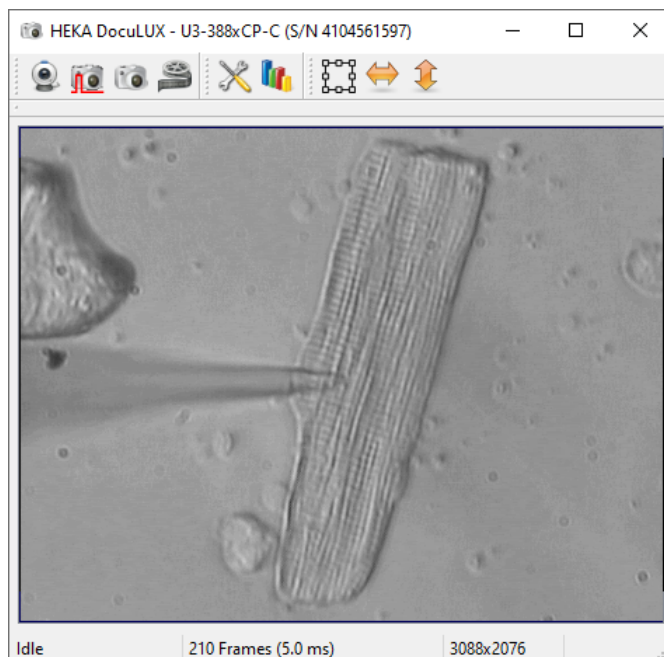


Figure 1.1: Image Window of DOCULUX showing a cardiac ventricular myocyte approached by a patch pipette.

## 1.1 Scope of the Program

Optical documentation of the cells or other specimens provides valuable information while performing a biological, biophysical or biochemical experiment. Advanced experimenters can easily judge e.g. the health condition of a cell by optical control. Further, optical documentation can help monitoring the progress of an ongoing experiment.

DOCULUX is the ideal tool for this purpose. It provides a high flexibility for the user. It can be used together with the well-known software programs of the PATCHMASTER family like PATCHMASTER, POTMASTER OR CHARTMASTER and it can be used as a stand-alone software program. Further, it can be triggered with every other software which is able to send out a TTL-like trigger.

Of course, the user achieves the highest usability when DOCULUX is used e.g. together with the PATCHMASTER software because the acquired images are stored together with the electrophysiological data and a corresponding link is provided assigning data to their appropriate images.

## 1.2 Requirements

### 1.2.1 Software Requirements

DOCULUX runs with either MS Windows 10 or 11. A 64-bit version is available for download on our [website](#).

DOCULUX can be used in combination with PATCHMASTER, POTMASTER or CHARTMASTER version  $\geq 2x92$ .

Image files can be stored either in TIFF (8-bit), BMP, JPG or PNG format. Video files are stored by default in the AVI format. Please use appropriate software to open or play the images or video files.

### 1.2.2 Hardware Requirements

The used camera models need a USB 3.0 port. There are no further hardware requirements.

## 1.3 Limitation of Use

The DOCULUX software is free for download on the HEKA website. However, the software does **only** work together with two selected camera models from IDS (more details in chapter Installation). You need to order the camera from HEKA or any other HEKA equipment distributor. Buying any other camera model or buying the camera somewhere else does not enable the software to run and we are not obliged to remedy the situation.

*Note: DOCULUX cannot be used simultaneously with SMARTLUX.*

Please [contact us](#) to get a quote for the DOCULUX Camera System.

## 1.4 Disclaimer

This *Product* relies on the tools of Microsoft Windows 10 or 11. HEKA is not responsible for: i) the contents of these third party products, ii) any links contained in these third party products, iii) changes or upgrades to these third party products and iv) for any consequential damages resulting from the use of these products.

This *Product* may not be reverse engineered, decompiled or disassembled without the express written consent of HEKA.

In no event shall HEKA be responsible for any incidental, punitive, indirect, or consequential damages whatsoever, (including but not limited to loss of data, privacy of data or other pecuniary loss), arising from or relating to the use, or the inability to use, this *Product* or the provision, or lack of provision, of support services.

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## 2 Installation

### 2.1 Camera Types

The usage of DOCULUX is limited to two camera models. A color camera model (U3-3880CP-C-HQ), and a monochrome camera model (U3-3880CP-M-GL).

#### 2.1.1 Color Camera



Figure 2.1: DOCULUX bundle content with color camera.

*Please be aware, that the camera is subject to change and may be different in size and appearance.*

The bundle (HEKA order number: 895380) contains:

- U3-3880CP-C-HQ IDS Camera (Rev.2.2)
- Trigger cable (Hirose to BNC), length 2 m
- USB 3.0 cable, length 3 m
- DocuLUX software, free download [here](#)



## 2.1. Camera Types

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### 2.1.1.1 Color Camera Specifications

The camera has the following specifications:

- Sensor: 1/1.8" CMOS
- Resolution: 3880x2076 pixel
- Aspect Ratio: 3:2
- Pixel Size: 2.4  $\mu\text{m}$
- Binning: 1x1, 2x2, 4x4, 8x8
- Depth: 12-bit (ADC)
- Objective Connection: C-mount
- Interface: Female USB 3.0 connector Type B (micro)
- Trigger Input: 8-pole female Hirose connector
- Dimensions: 29 x 29 x 29 mm / 1.14 x 1.14 x 1.14 inches (H/W/L)
- Weight: 48 g / 1.69 oz

### 2.1.2 Monochrome Camera

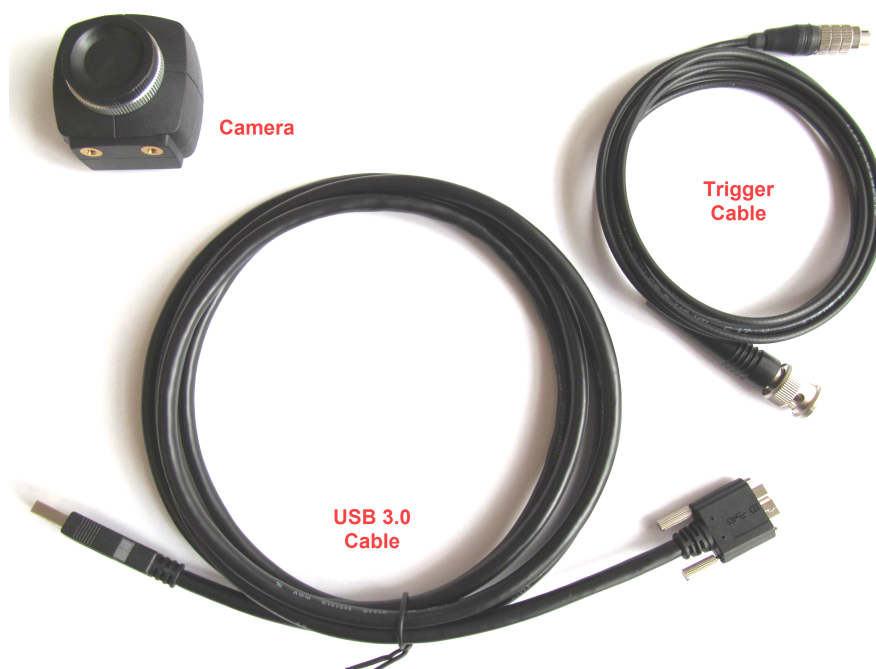


Figure 2.2: DOCULUX bundle content with monochrome camera.

*Please be aware, that the camera is subject to change and may be different in size and appearance.*

The bundle (HEKA order number: 895381) contains:

- U3-3880CP-M-GL IDS Camera (Rev.2.2)

- Trigger cable (Hirose to BNC), length 2 m
- USB 3.0 cable, length 3 m
- DocuLUX software, free download [here](#)

### 2.1.2.1 Monochrome Camera Specifications

The camera has the following specifications:

- Sensor: 1/1.8" CMOS
- Resolution: 3880x2076 pixel
- Aspect Ratio: 3:2
- Pixel Size: 2.4  $\mu\text{m}$
- Binning: 1x1, 2x2, 4x4, 8x8
- Depth: 12-bit (ADC)
- Objective Connection: C-mount
- Interface: Female USB 3.0 connector Type B (micro)
- Trigger Input: 8-pole female Hirose connector
- Dimensions: 29 x 29 x 29 mm / 1.14 x 1.14 x 1.14 inches (H/W/L)
- Weight: 48 g / 1.69 oz

## 2.2 Installing the Camera

The described installation process handles both camera types.

- Screw the camera to the microscope via the C-mount connection.
- Download the latest DOCULUX version (64-bit) from our [website](#).
- Unzip the downloaded file
- Execute the IDS camera software "ids\_peak\_2.5.0.0.exe" and follow the instructions to install the driver.
- Once the driver installation has finished successfully, you can connect the camera to the PC via the provided USB cable.
- Connect the provided trigger cable.

## 2.3 Installing DocuLUX

The described installation process is independent of the camera type.

- Download the latest DOCULUX version (64-bit) from our [website](#).
- Unzip the downloaded file

- Execute the DOCULUX installer. Make sure that all content is installed into the PATCHMASTER installation folder.
- Either start PATCHMASTER and activate DOCULUX via the Configuration of PATCHMASTER or execute DOCULUX directly if you do not want to use it together with PATCHMASTER.

*Note: Please note that DOCULUX does only run with PATCHMASTER version 2x92 or more recent.*

### 3 Image Window

The DOCULUX software has one main window which is called the Image window. It can have attached bays for the *Properties* or the *Histogram* settings. At the upper image border the main function icons are depicted which are explained in the following sections.

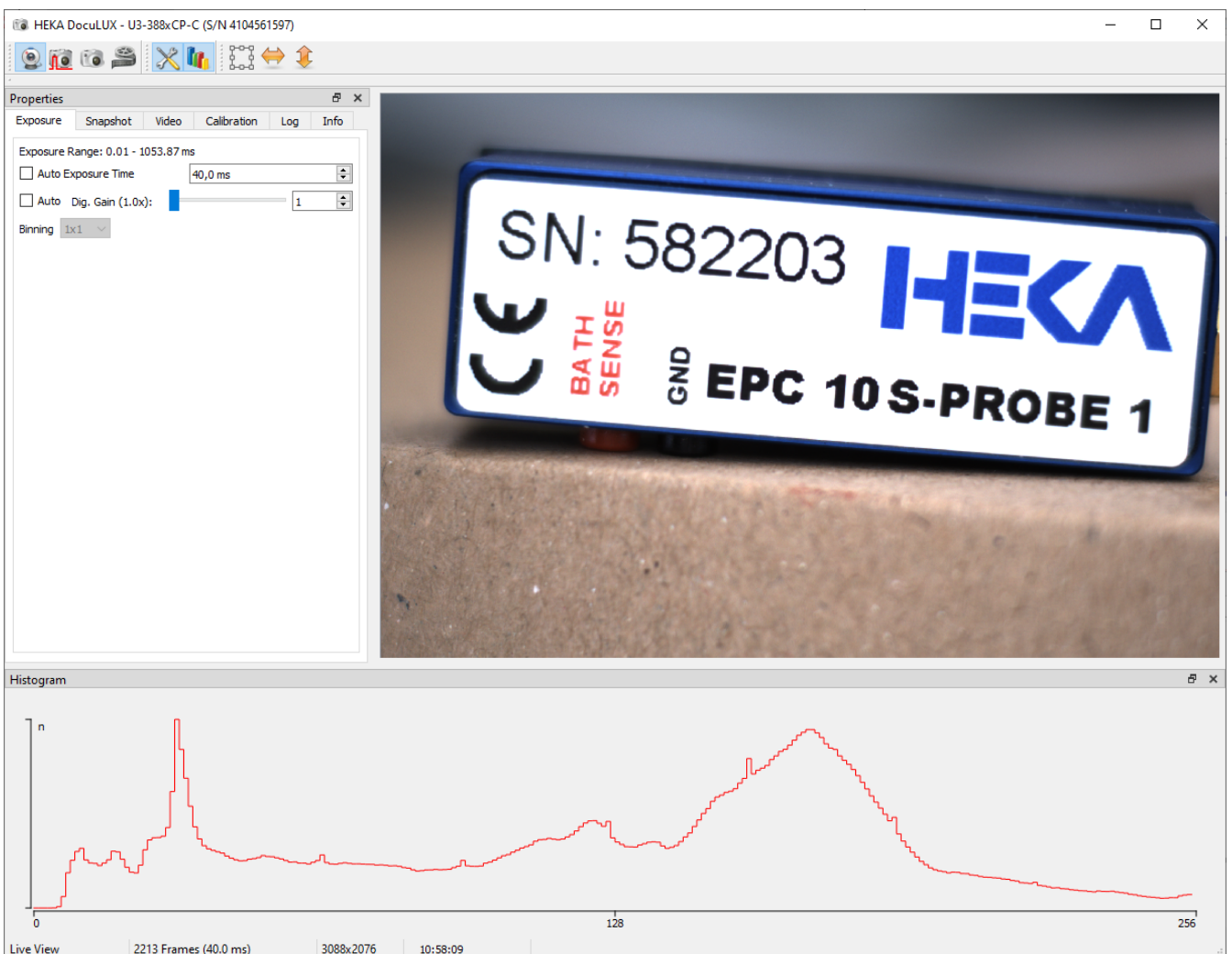


Figure 3.1: Properties and Histogram settings of DOCULUX. Image Window of DOCULUX with activated Properties and Histogram settings arranged in one main window.

### 3.1 Live View

The *Live View* option shows a continuous stream of images in the Image window. The number of incoming images is displayed at the lower image border of the Image window.



Figure 3.2: Active Live View option of DOCULUX.

### 3.2 Triggered Snapshot

When the *Triggered Snapshot* is active DOCULUX is waiting for an incoming trigger via the trigger input connection of the camera. While this option is active no other image acquisition is possible.

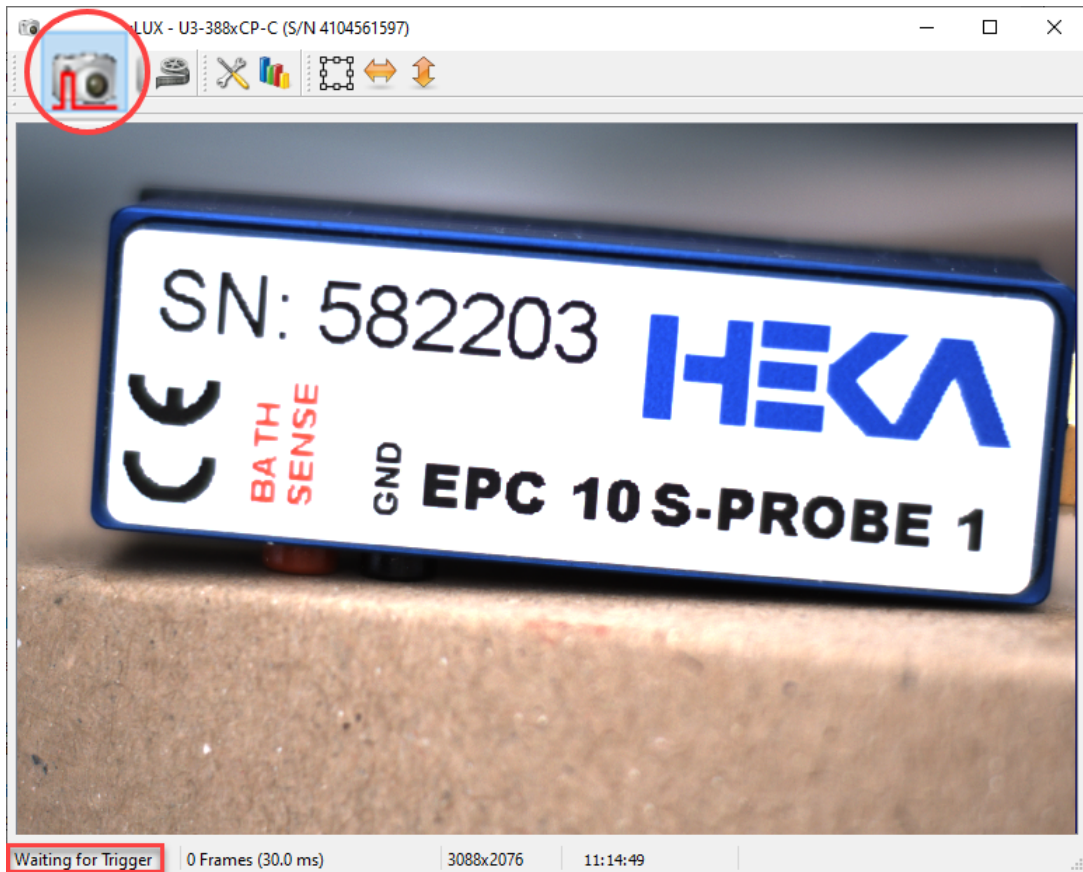


Figure 3.3: Active Triggered Snapshot option of DOCULUX. The software is waiting for an incoming trigger to start the image acquisition.



### 3.3 Snapshot

By clicking on the *Snapshot* button the snapshot image will be immediately acquired. The number of acquired *Snapshots* is indicated at the lower image border of the Image window.



Figure 3.4: Snapshot button of the Image Window. The number of snapshots is provided at the lower border of the dialog.

### 3.4 Video

By pressing the *Video* button the acquisition of a video is started immediately. The number of acquired frames is indicated at the lower image border of the Image window.

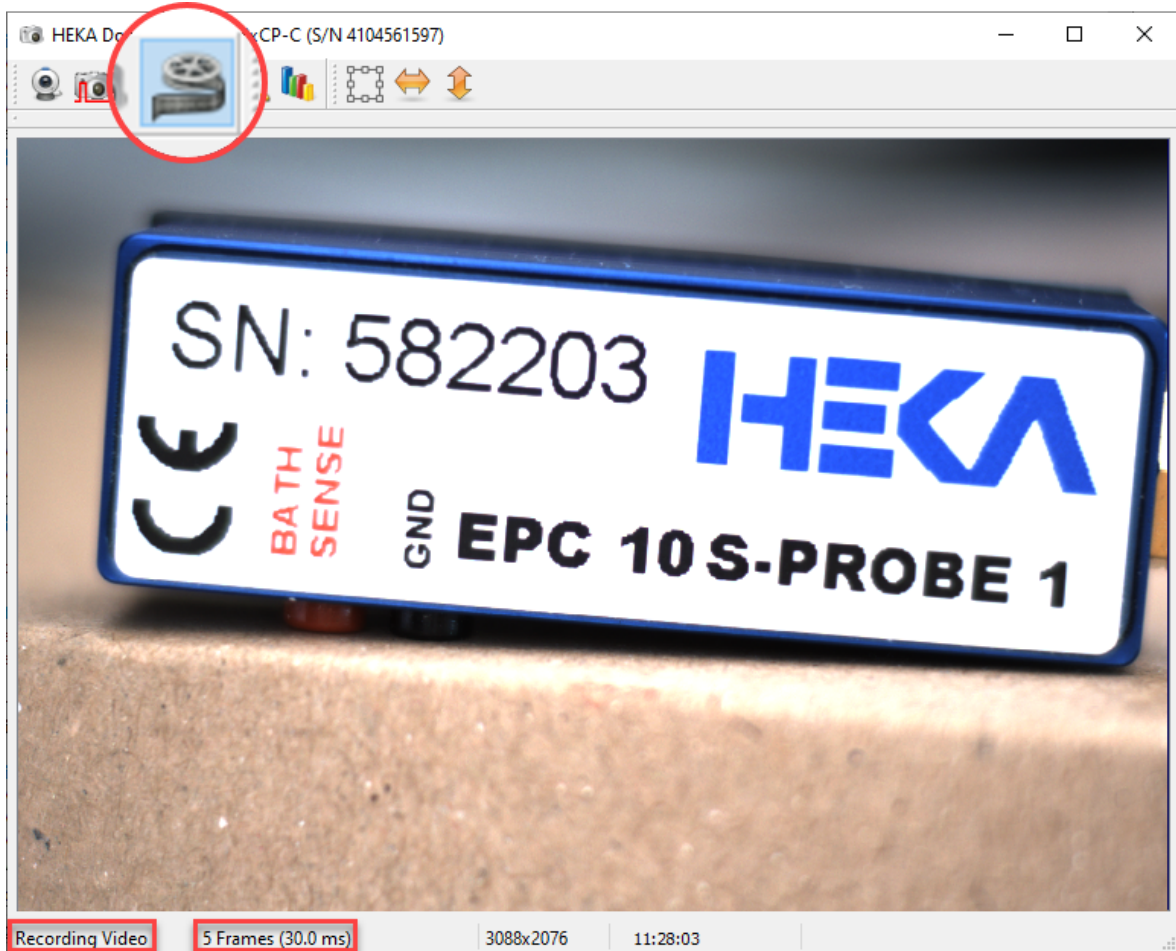


Figure 3.5: Video button of the Image Window. The number of frames acquired during the video acquisition is provided at the lower border of the dialog.

### 3.5 Properties

When activating the *Properties* button another extension bay gets visible in the Image window. This dialog can be rearranged within the Image window or it can get detached from the Image window.



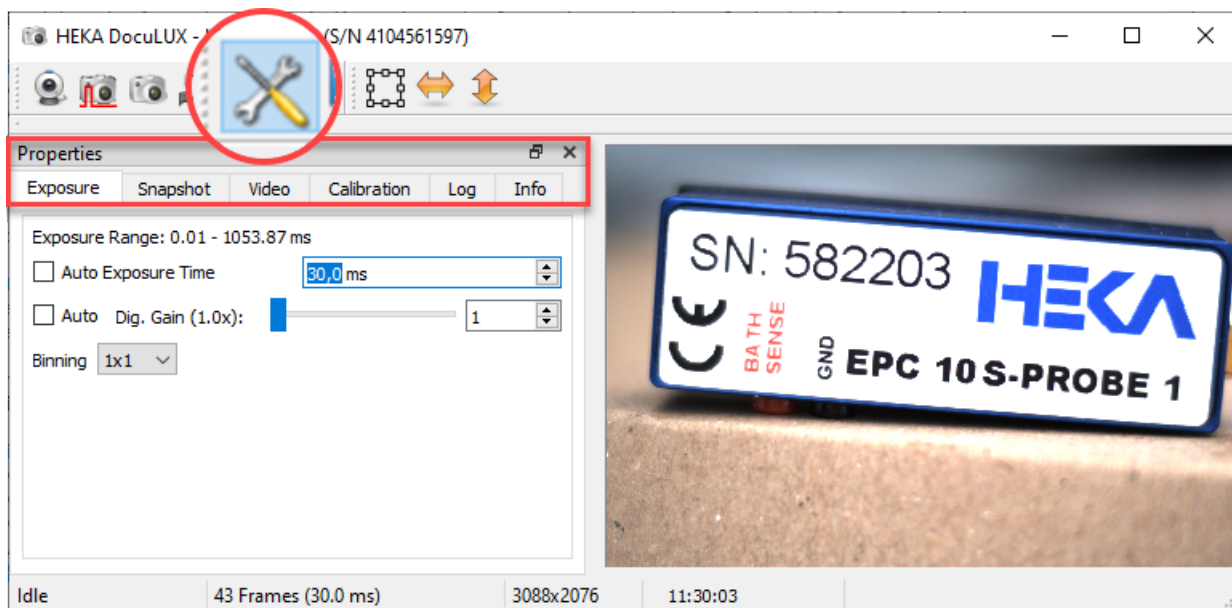


Figure 3.6: Expansion bay showing the Properties settings of DOCULUX.

In the subsequent sections each individual tab of the Properties dialog is explained.

*Note: The icons for Properties and Histogram can be active at the same time.*

*Note: The availability of the following settings depend on the used camera model. Hence, not all parameters might be displayed.*

### 3.5.1 Exposure

In the Exposure tab of the Properties section one can adjust the exposure settings of the camera.

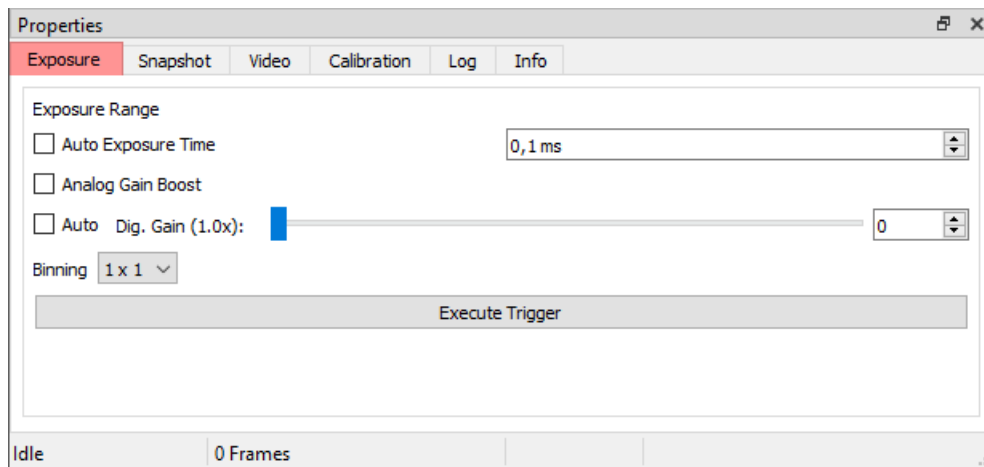


Figure 3.7: Exposure settings of the Properties dialog.

- Exposure Range: Shows the possible exposure range if the option *Auto Exposure Time* is active.
- Auto Exposure Time: If this checkbox is enabled the *Exposure Time* is calculated by DOCULUX.
- Analog Gain Boost: Amplification of the analog signal directly on the sensor by a factor of "2". This amplification increases the total brightness of the image and increases the contrast level.
- Auto Digital Gain: Digital amplification of the brightness values by a factor of 1x to 100x.
- Binning: The increase of the *Binning* factor decreases the image size and the resolution but allows faster pixel readout. In doing so signal to noise ratio of the images increases.

### 3.5.2 Snapshot

In the Snapshot tab of the Properties the settings for taking *Snapshots* and *Triggered Snapshots* are defined.

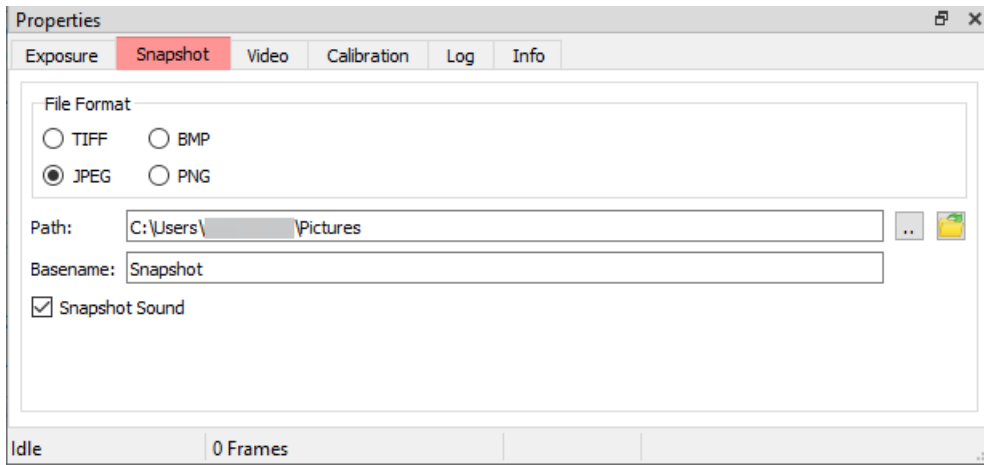


Figure 3.8: Snapshot settings of the Properties dialog.

- **File Format:** Select the *File Format* of the acquired *Snapshots*. Available *File Formats* are: *TIFF*, *BMP*, *JPEG* and *PNG*.
- **Path:** Defines the data path where the *Snapshots* are stored. If you use DOCULUX together with the PATCHMASTER software the *Path* is set by PATCHMASTER.
- **Basename:** Default name of the acquired *Snapshots*. An index number is automatically added to the *Basename*.
- **Snapshot Sound:** Enable or disable the checkbox to generate a sound while a *Snapshot* is taken.

### 3.5.3 Video

In the Video tab of the Properties the settings for taking *Videos* are defined.

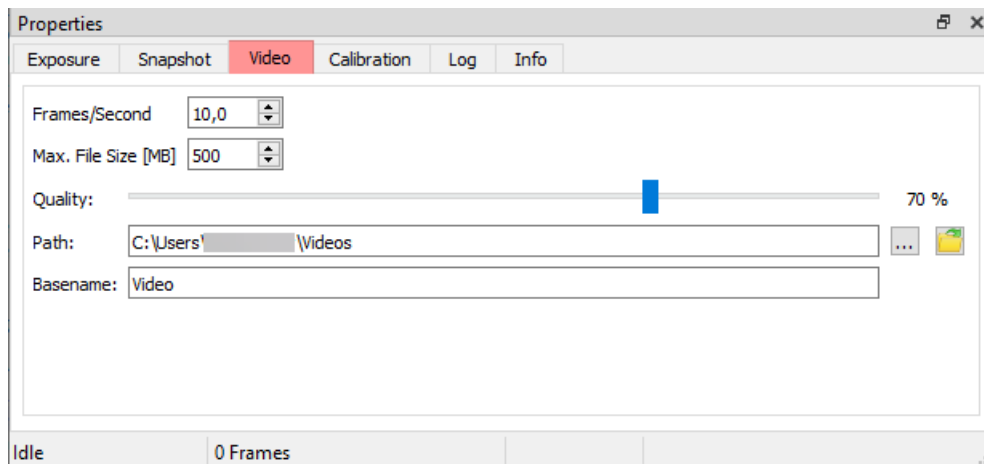


Figure 3.9: Video settings of the Properties dialog.

- **Frame/Second:** Sets the image frequency (Frames/Second) of the video sequence.
- **Max. File Size [MB]:** Defines the maximum file size of an acquired video sequence.
- **Quality:** Defines the compression level of the image, measured in percentage of the quality level. An image at 100% quality has almost no loss and has a higher file size, whereas lower percentages store images with higher compression and therefore lower data quality and file size.
- **Path:** Defines the location or folder where the acquired video sequence are stored. If you use DOCULUX together with the PATCHMASTER software the *Path* is set by PATCHMASTER.
- **Basename:** Sets the default file name of the video sequence. Video sequences with the same file name will get an additional index number.

### 3.5.4 Calibration

In the Calibration tab one can define the settings for the image calibration. Several options for image calibration are available and different calibration settings can be stored.

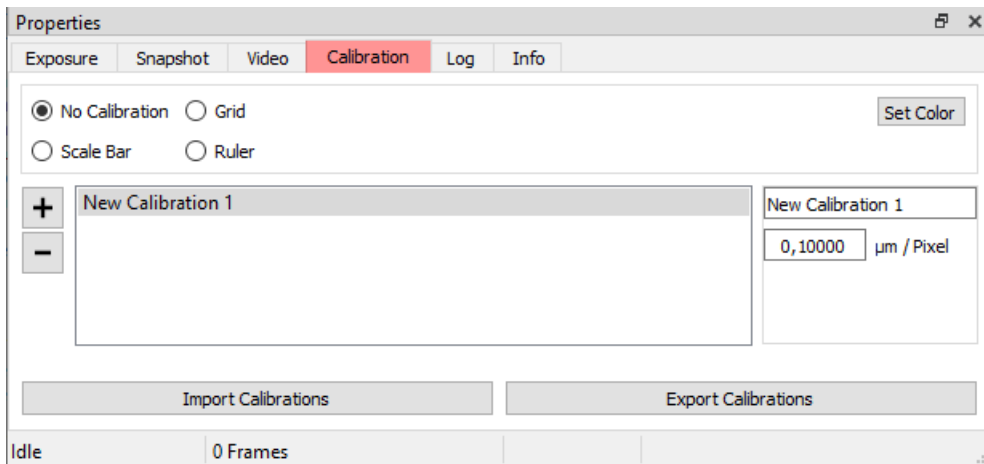


Figure 3.10: Calibration settings of the Properties dialog.

- No Calibration: No calibration is applied.
- Grid: The image gets overlaid with a grid according according to the calibration scale.
- Scale Bar: A scale bar according to the calibration scale is included into the image.
- Ruler: A ruler bar on the left and top image panel is display.
- Set Color: Allows to select the color of the calibration display.
- New Calibration Set: DOCULUX can manage up to five different sets of calibrations. To create a new calibration set one just needs to press the “+” button and enter an appropriate name.
- Import Calibrations: Import previously saved calibration settings.
- Export Calibrations: Export the calibration settings to save either a backup of it or to use the settings on a different setup.

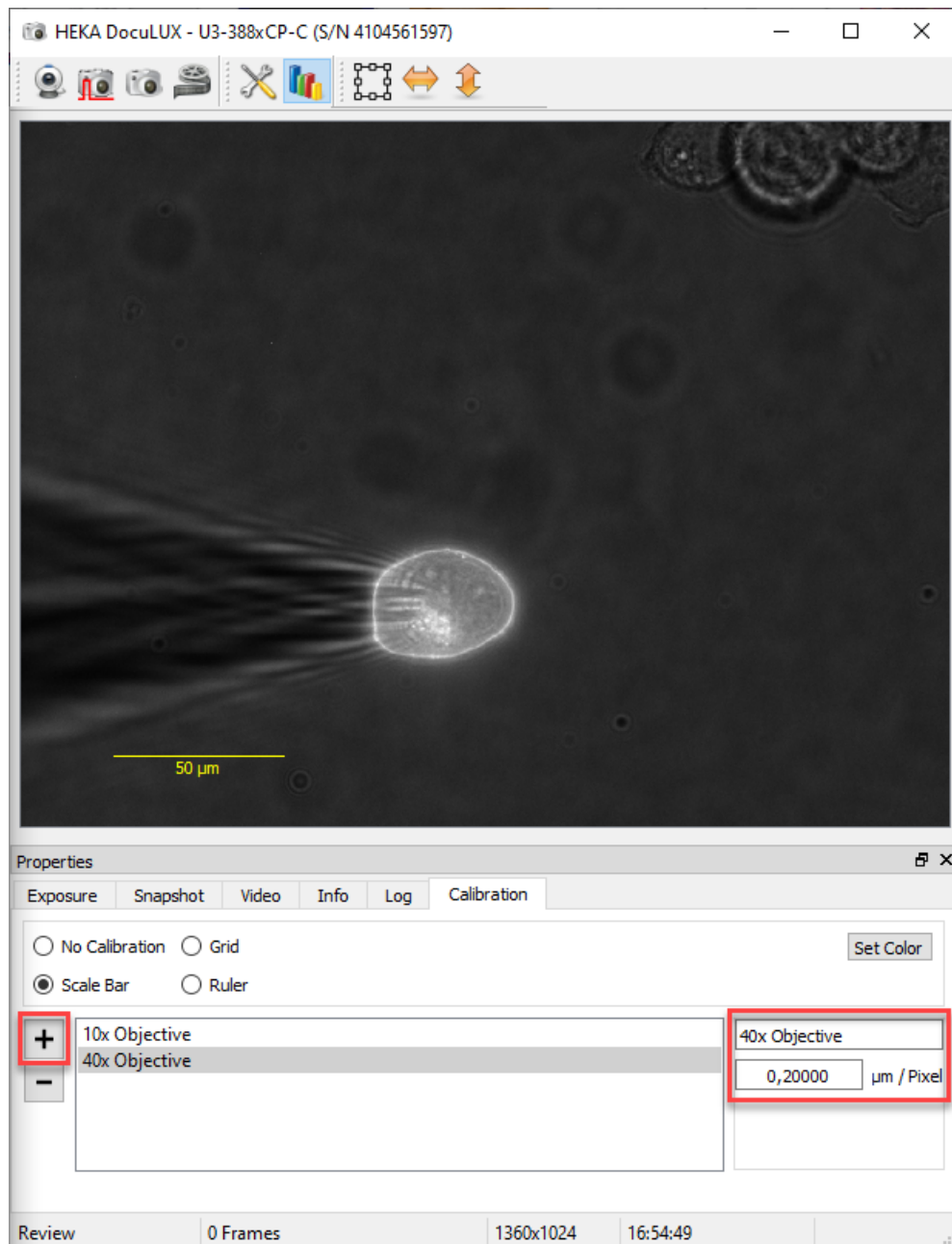


Figure 3.11: Creating new calibration sets.

It is also possible to measure distances or diameters of your specimen. As shown in the example below one can left-click somewhere in your image at any time and drag a straight line into any structures. According to the set calibration scale the corresponding length is provided, too.

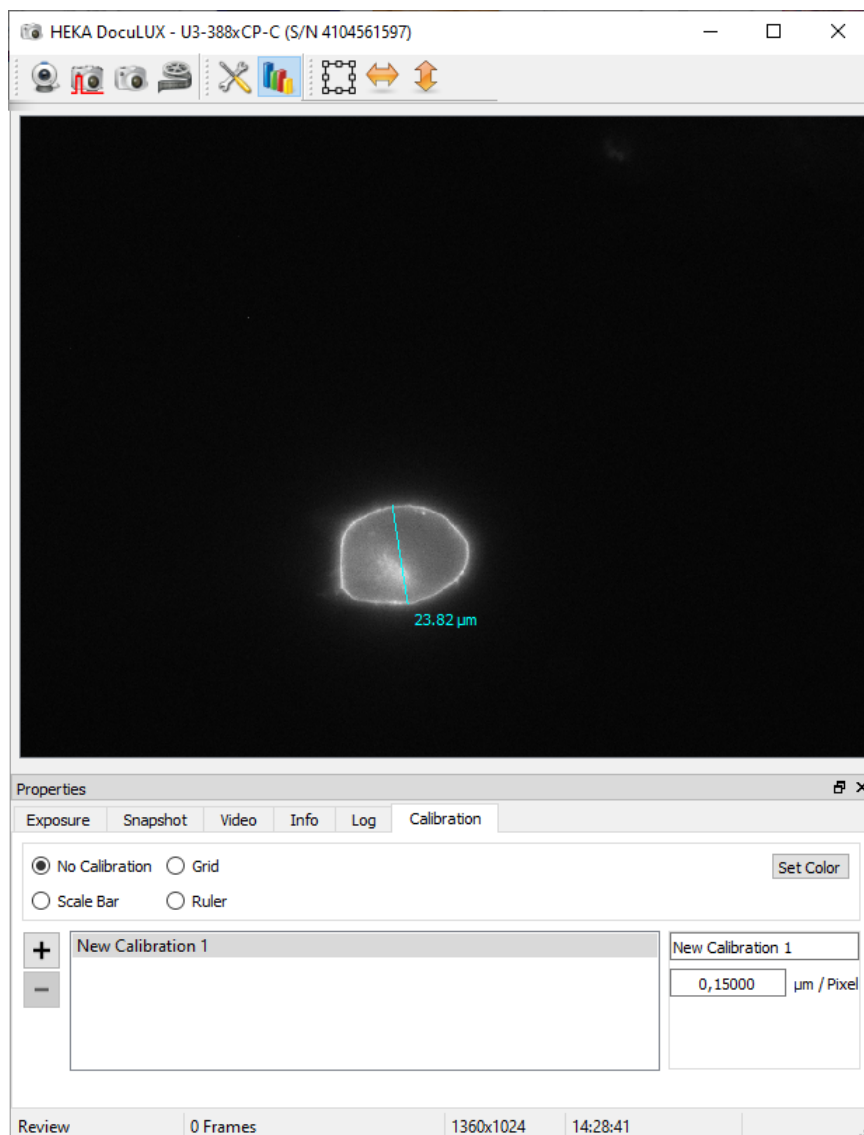


Figure 3.12: Measure tool of DOCULUX. At any time one can measure distances or diameters in the acquired images. The set calibration scale effects the calculated length of the dimension line.

### 3.5.5 Log

The Log tab of the Properties lists status messages and error messages.

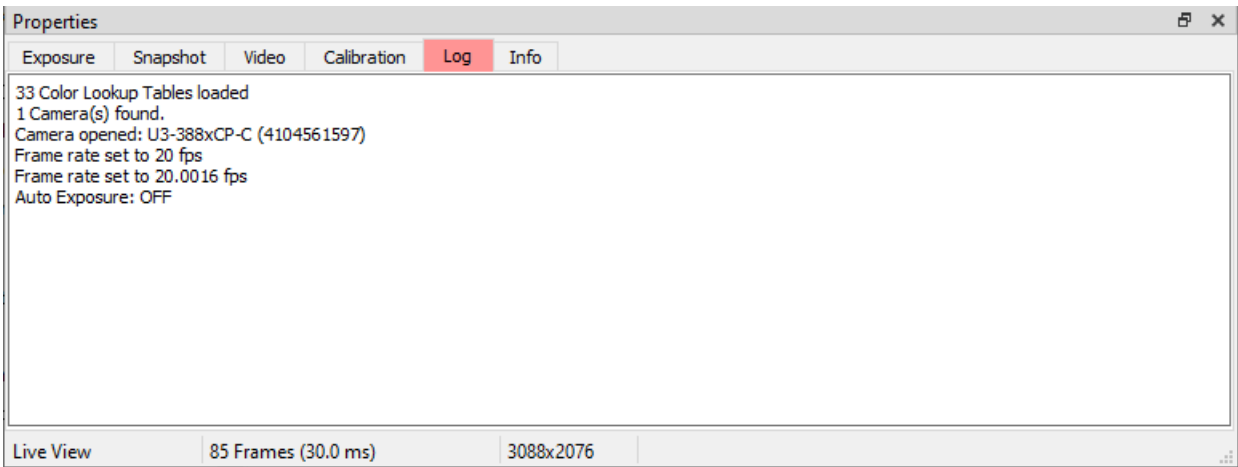


Figure 3.13: Log settings of the Properties dialog.

### 3.5.6 Info

The Info tab of the Properties lists basic information about the used camera and the software.

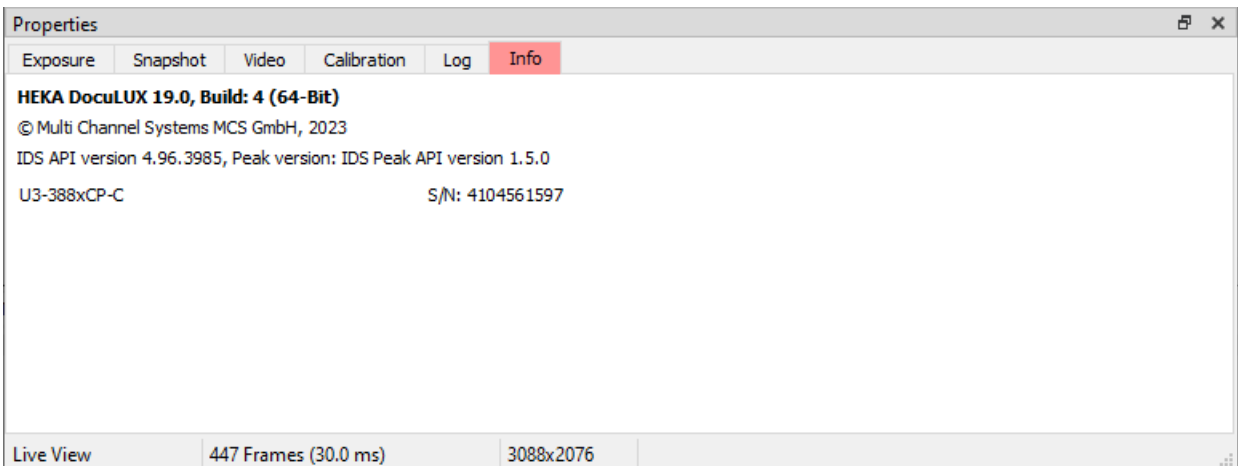


Figure 3.14: Info settings of the Properties dialog.

## 3.6 Histogram

When activating the *Histogram* button another panel is attached to the Image Window showing a histogram of the latest acquired image. Due to the 8-bit resolution of the camera there are 256 color or grey values available which are plotted on the X-axis (intensity). The Y-axis shows the number of pixels with the corresponding tonal value.



### 3.6. Histogram

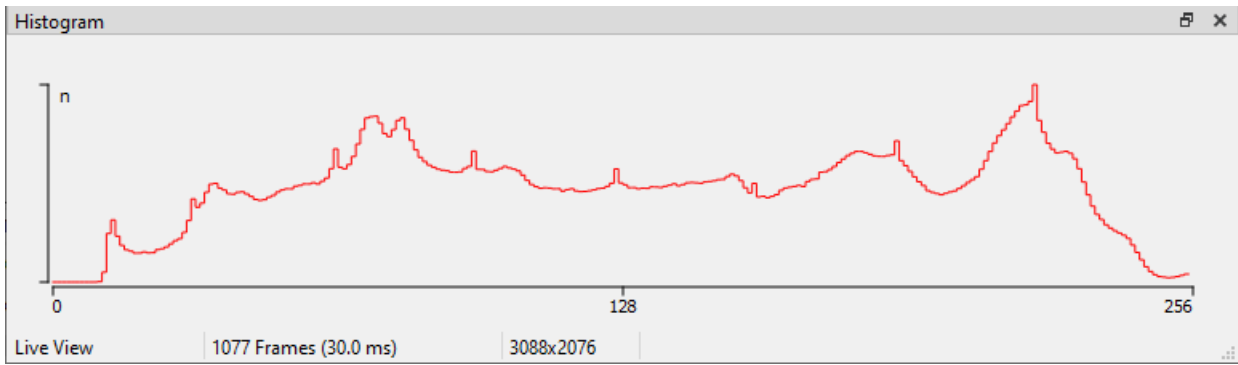


Figure 3.15: Image Histogram of DOCULUX. The Y-axis plots the number of pixels for each tonal variation on the X-axis (intensity).

By clicking with the mouse onto the histogram curve the intensity at that particular point of the histogram is shown.

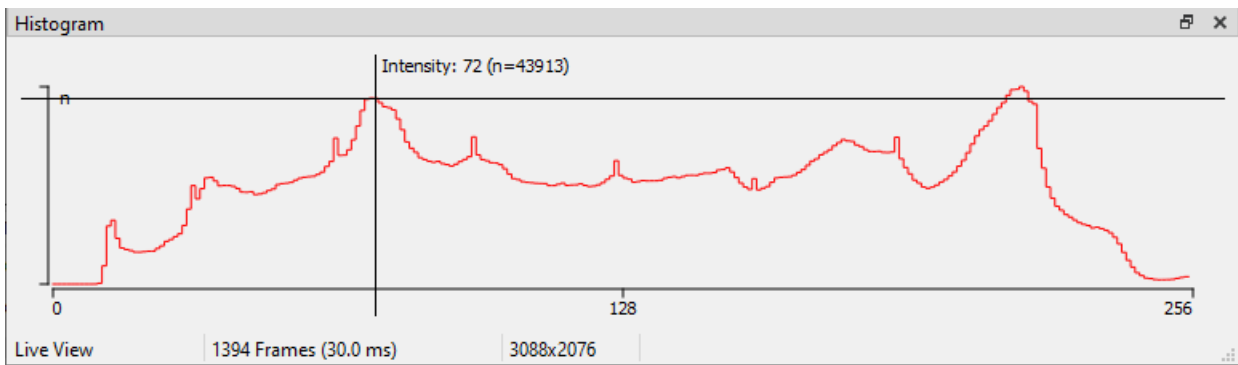


Figure 3.16: Reading out the intensity of the histogram.

### 3.6. Histogram

Further, with a right-click on the *Histogram* a context menu opens providing two options:

- Y Scale Mode: Sets the Y scale either to linear “n” or logarithmic “log (n)” mode.
- Export Histogram: Exports the histogram values to a \*.csv file.

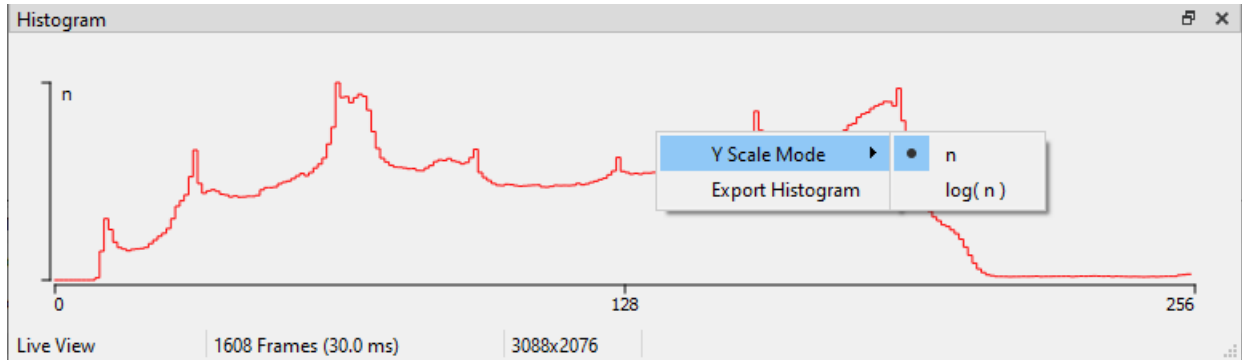


Figure 3.17: Context menu of histograms.

*Note: The buttons for Properties and Histogram can be active at the same time.*

## 3.7 Color Lookup Tables

*This feature is only available with the monochrome camera.*

DOCULUX offers a full set (32) of Color Lookup Tables. The purpose of these pseudo-color tables is to increase the contrast of your images. By selecting one of the color tables the pixel intensity gets a pseudo-color assignment.

## 3.8 Area of Interest

Limiting the image section to areas of your interest is extremely helpful for the experimental procedure. You can i.e. focus on a specific structure depicted in your image.

**Set AOI:** By clicking on the button *Set AOI* another dialog called *Set Area of Interest* opens. This dialog provides the following options:

- X: X-position of the area of interest in respect to the full view image
- Y: Y-position of the area of interest in respect to the full view image
- Width: Pixel value of the width of the area of interest
- Height: Pixel value of the height of the area of interest
- Reset to Sensor Size: Resets the area of interest to the default settings



Figure 3.18: Set Area of Interest dialog with full view image.

The picture above shows a full view snapshot of your specimen. While narrowing (use the red cursors lines for image size definition) the area for the imaging process you can increase the imaging speed considerably.



Figure 3.19: Area of Interest selection.

After you defined your area of interest (AOI) you confirm the selection by clicking on the *OK* button. The *Set Area of Interest* dialog closes and the area of interest is shown in your *Image* window.

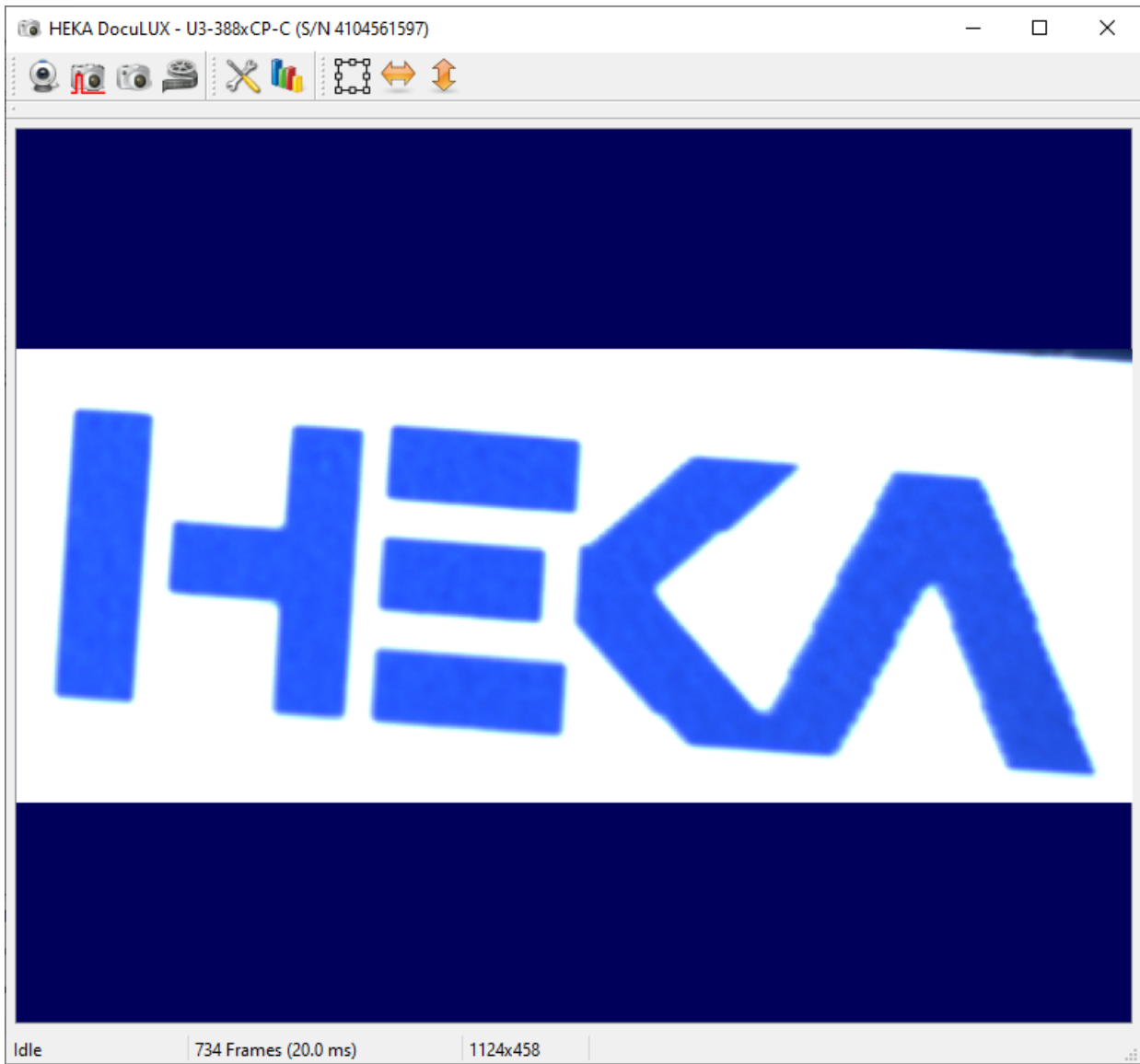


Figure 3.20: Area of Interest display.

**Reset:** Resets all Area of Interest settings and restores the full view image.

### 3.9 Flip

By using the *Vertical Flip* or *Horizontal Flip* button one can flip the image either horizontally or vertically which avoids re-mounting the camera itself.



Figure 3.21: Horizontal flip of the image.

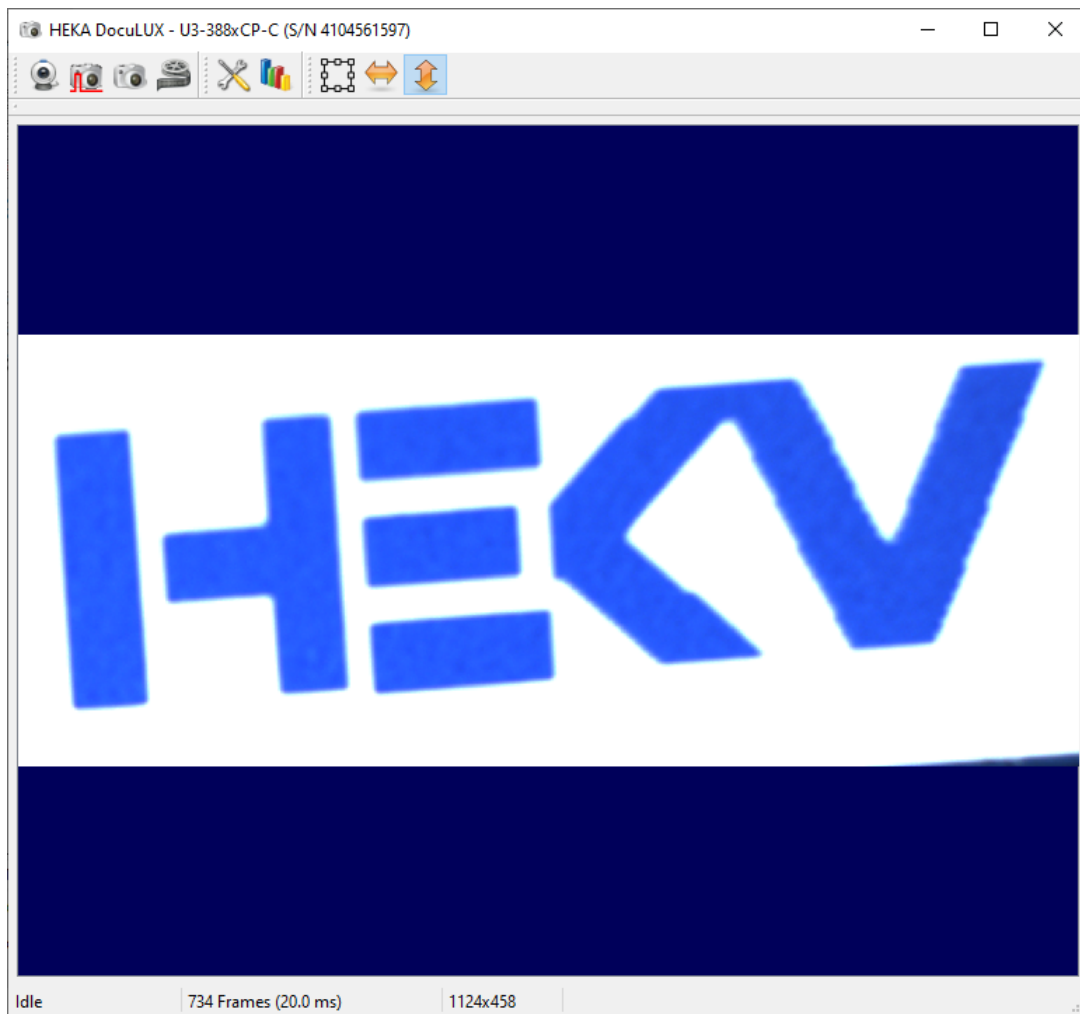


Figure 3.22: Vertical flip of the image.

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## 4 DocuLUX Configurations

There are several options how to use DOCULUX:

- Use with PATCHMASTER (including Batch Communication)
- Use with PATCHMASTER (without Batch Communication)
- Use as Stand-alone program
- Use Triggered with a third-party program

In the following sections we explain all possible configurations.



## 4.1 Using DocuLUX with PATCHMASTER and Batch Communication

Using DOCULUX together with PATCHMASTER offers the most benefits. Therefore, you need to go to the Configuration of PATCHMASTER and activate DOCULUX.

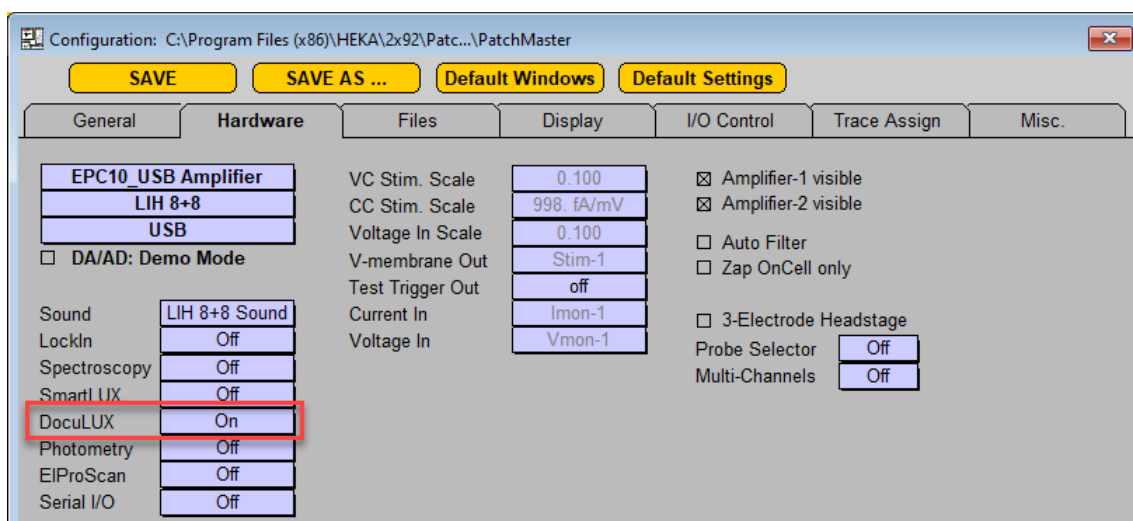


Figure 4.1: Turning on DOCULUX.

While doing so the *Batch Communication* is activated. This is indicated by a message written into the Notebook window of PATCHMASTER:

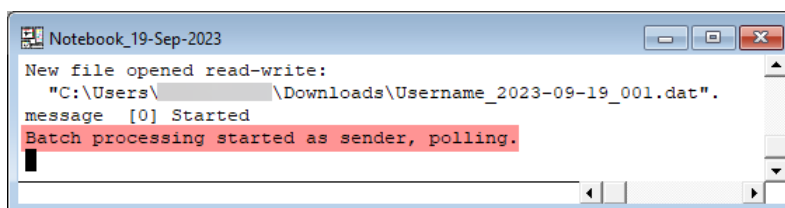


Figure 4.2: Active Batch Communication writes into the Notebook window.

***Note:** The term **Batch Communication** describes the communication process between PATCHMASTER and any other software via defined communication commands. The advantage is that almost every program is able to communicate with PATCHMASTER and access all its functionality. For further information about the Batch Communication we refer to the tutorial [Controlling PATCHMASTER from another application](#).*

Once the *Batch Communication* is activated, DOCULUX and PATCHMASTER communicate with each other. This provides the following advantages:

- Controlling image or video acquisition via the Protocol Editor event “DocuLUX”
- Linking acquired images to the data

In the next sections we explain how this can work either in the Pulse Generator or in the Protocol Editor.

### 4.1.1 Using the Pulse Generator

When it is necessary to acquire one or more images of your specimen in parallel to your electrophysiological recording it is recommended to use the Pulse Generator. There are a few crucial steps to make this triggered image acquisition work:

1. Add another channel which defines the trigger output (either analog or digital trigger). Therefore, click onto the DA area of the next free output channel in your PGF sequence.

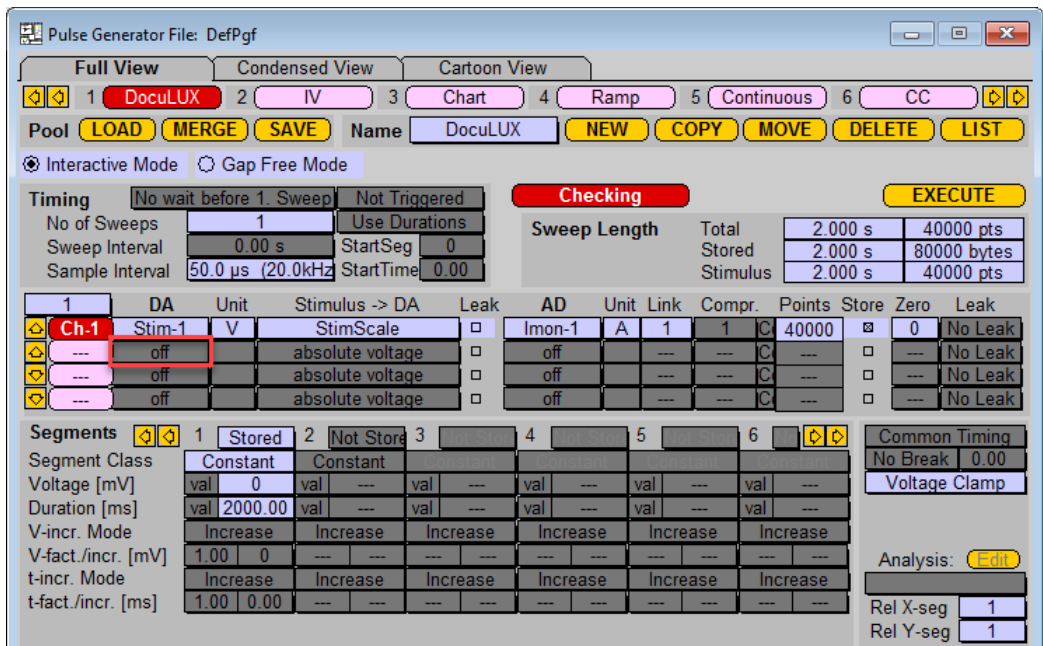


Figure 4.3: Adding another output channel for the camera trigger.

2. A selection list opens and there you can select either an analog or digital trigger output. The red squares mark the free analog and digital outputs available at the front panel of the EPC 10 USB. We select *Dig-0* in our example.

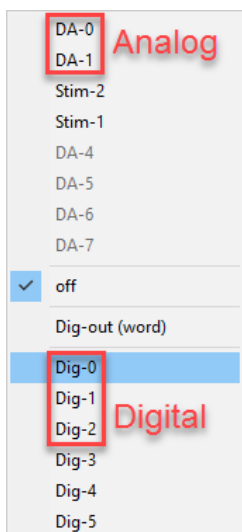


Figure 4.4: Output channel selection list.

3. In the next step we assign the usage for a camera trigger to this channel. To do so, click onto the *Stimulus to*

DA area of channel "2".

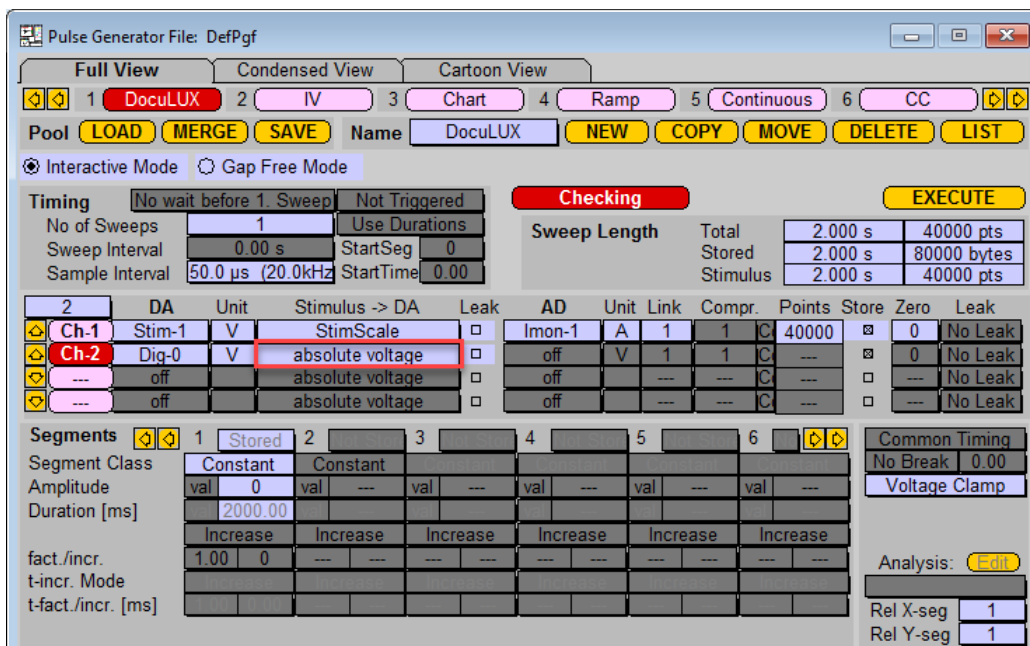


Figure 4.5: Defining the output channel as a camera trigger channel.

4. Another selection list opens. There, we select the option *use for Camera Trigger*.

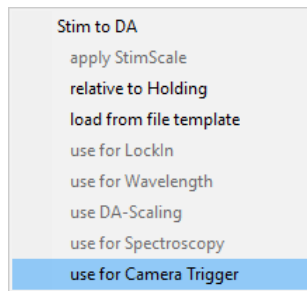


Figure 4.6: Setting the output channel as a camera trigger channel.

5. The camera trigger assignment for this channel will change the timing of the segments of this channel automatically to *Separate Timing*.

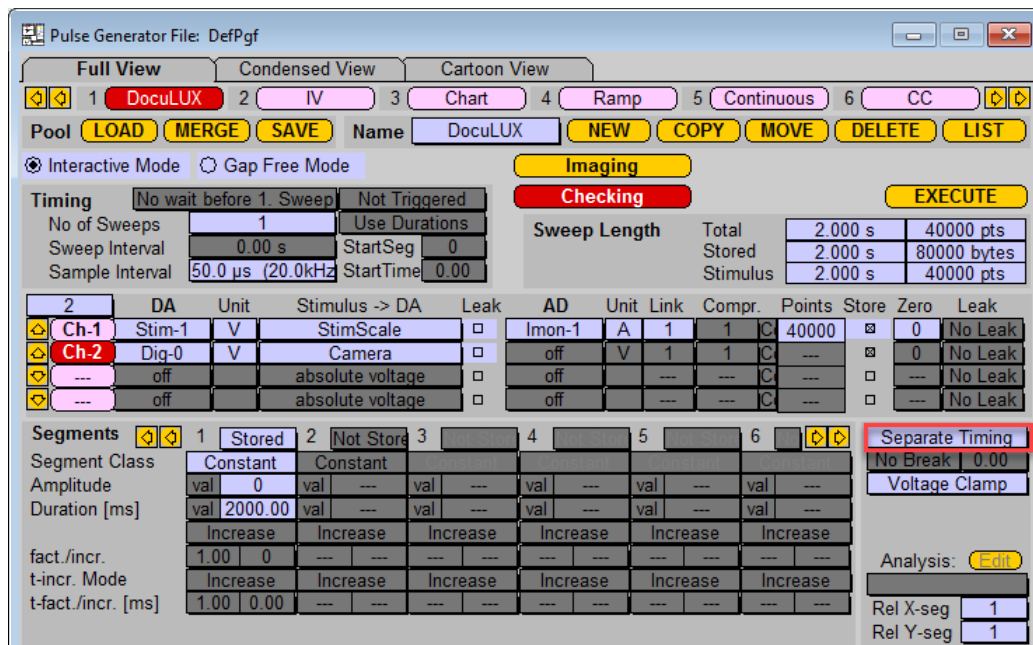


Figure 4.7: Separate Timing of the camera trigger channel.

6. Use the yellow *Imaging* button to customize your triggers in respect to *Number of Cycles*, *Cycle Time*, *Start Wait Time* and *Exposure Time*.

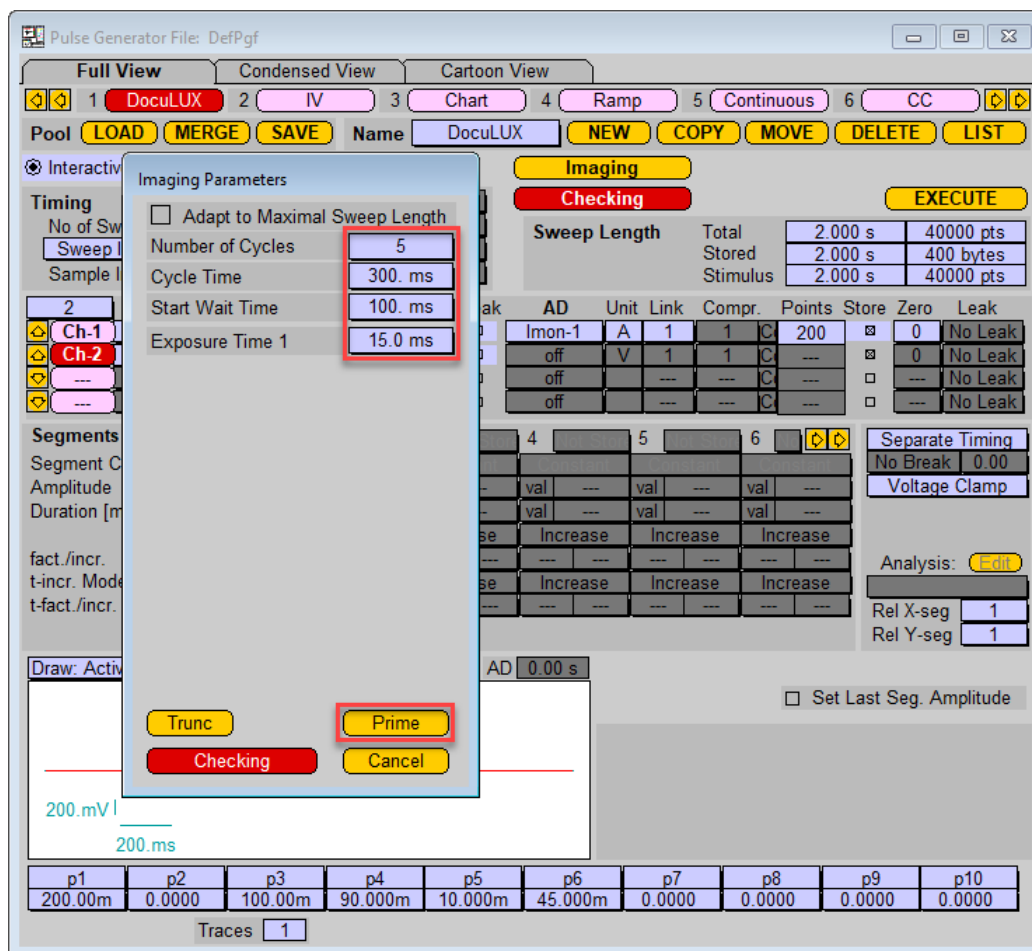


Figure 4.8: Defining the cycle parameters for the output camera triggers.

The cycle parameters are defined as follows:

- **Adapt to Maximal Sweep Length:** Number of cycles calculated in respect to the duration of the longest output channel.
- **Number of Cycles:** Determines how many times the first *Number of Segments* are duplicated. In case *Adapt to Maximal Sweep Length* is checked, it shows how many cycles have been fit into the stimulus.
- **Cycle Time:** Total Duration of one cycle
- **Start Wait Time:** Defines a waiting time before the first cycle starts. This parameter can be used to shift the start of the first cycle in respect to your electrophysiological recording defined in other channels.
- **Exposure Time 1:** Time for image exposure during live image acquisition.

*Note: A Cycle defines the work process to set the imaging parameters like Exposure Time, Waiting Times etc.. Depending on the length of your stimulus and the length of one cycle you can have several iterations of a cycle in one stimulation run (Sweep).*

7. Once you are set, press the *Prime* button to generate the segment pattern for your camera channel.
8. Have a look for the cartoon of the Pulse Generator to check the distribution of your camera triggers. There is an additional first segment which allows to shift the starting time (*Start Wait Time*) in respect to the first channel settings.

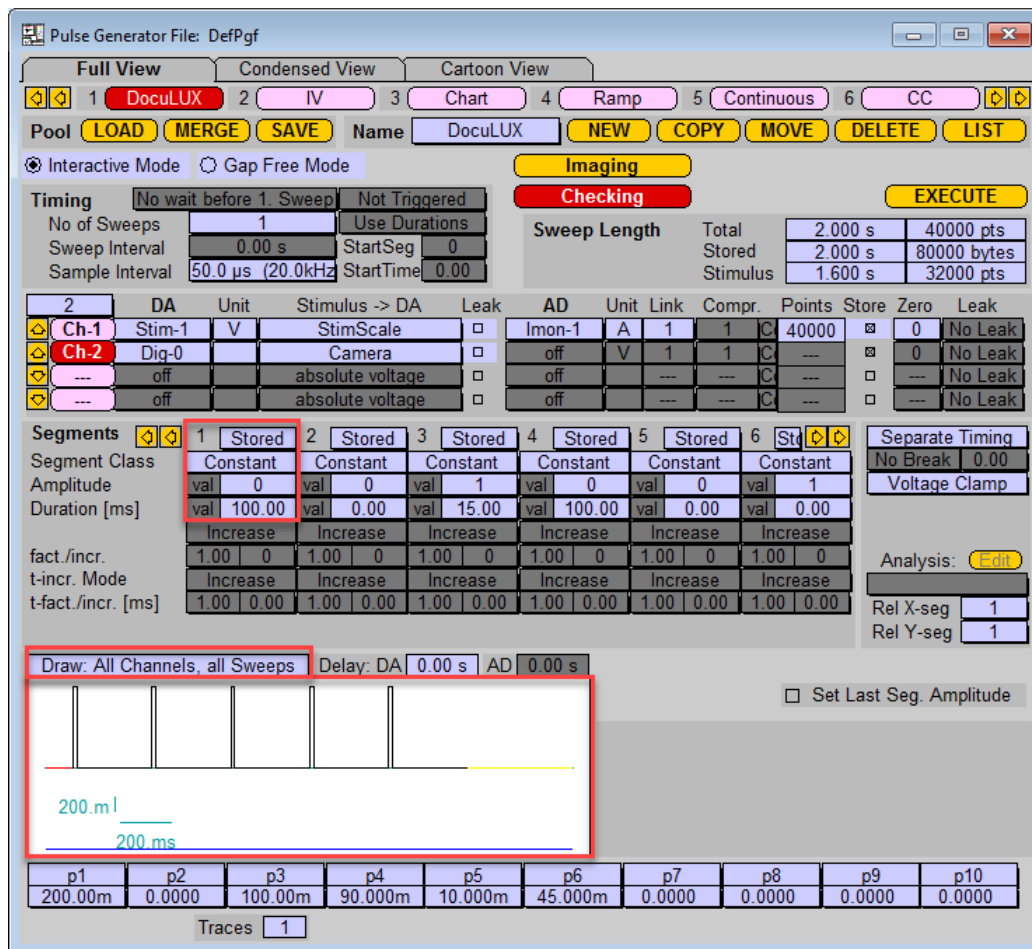


Figure 4.9: Final settings of the camera trigger output channel.

9. Now, you are ready to go and execute the stimulation sequence.

The acquired images are stored by default in the Data folder of your PATCHMASTER installation together with your HEKA data file (\*.dat).

If you browse through your data the first acquired image of a Series/Sweep will be displayed in the Image window of DOCULUX.

## 4.1. Using DocuLUX with PATCHMASTER and Batch Communication

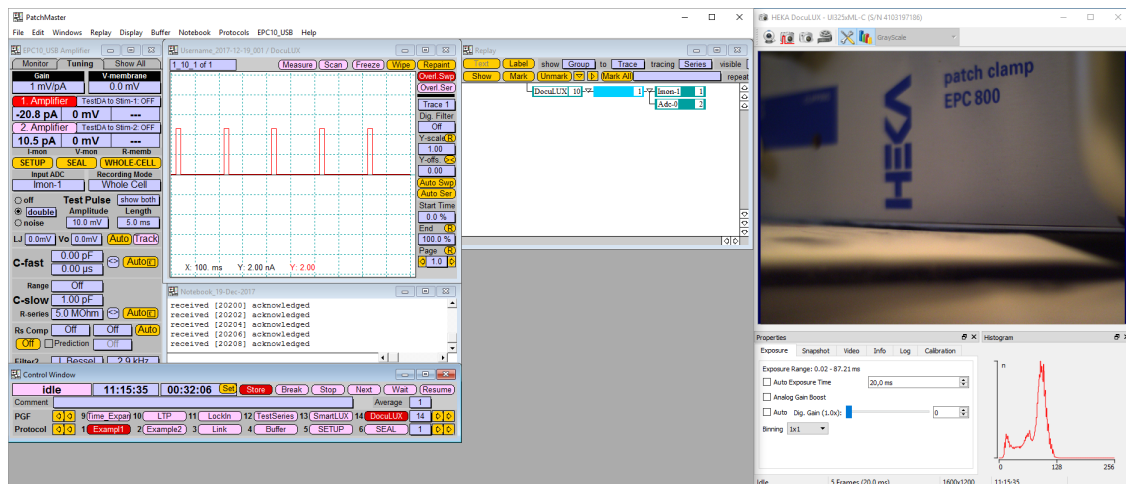


Figure 4.10: Data and Image Linking of DOCULUX. While replaying the data in the Replay Tree the linked images are shown in the Image window.

*Note: Images acquired via triggered acquisition and Batch Communication are always saved as TIFF files. When acquiring several images during one sweep only the first image of the TIFF stack is displayed in the Image window of DOCULUX.*



### 4.1.2 Using the Protocol Editor

Another advantage of using DOCULUX together with PATCHMASTER using Batch Communication is the availability of the DOCULUX Protocol Editor event. This event allows to start and stop video sequences, taking triggered snapshots or start and stop the live acquisition mode.

Open the Protocol Editor in the PATCHMASTER software. We created a new sequence to show the “DocuLUX” event features.

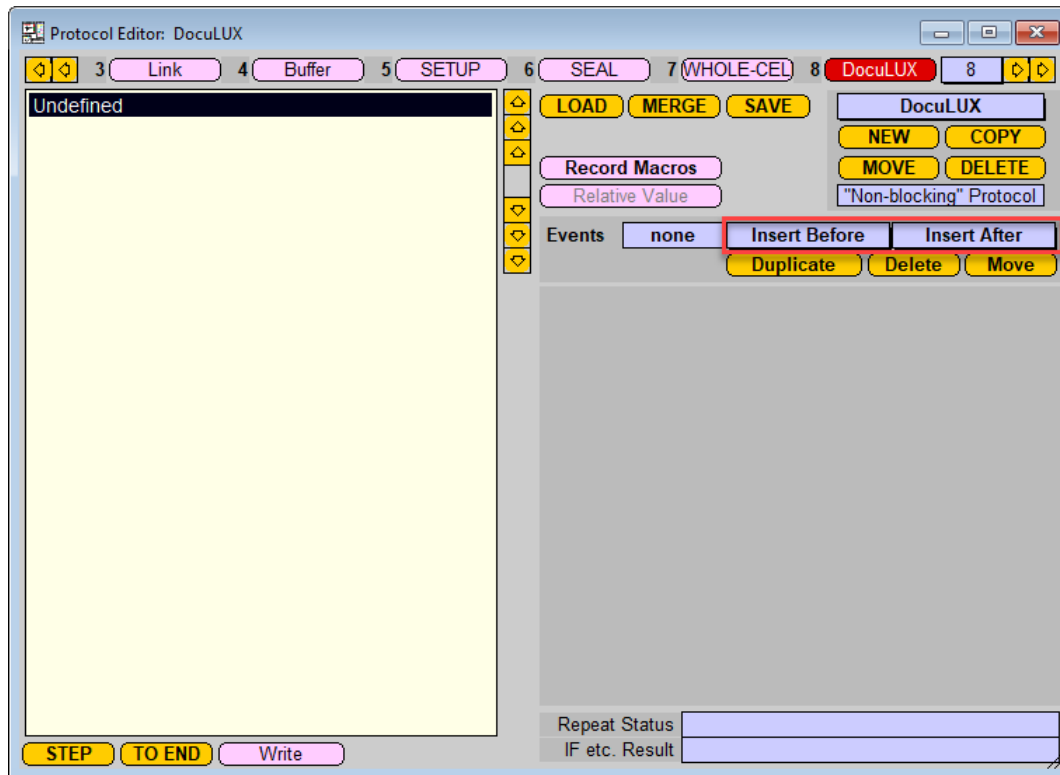


Figure 4.11: Protocol Editor of PATCHMASTER.

Click onto the event selection menus *Insert Before* or *Insert After* in the event area. Scroll down and have a look for the *Extension* group. There, select *DocuLUX* to insert the event.

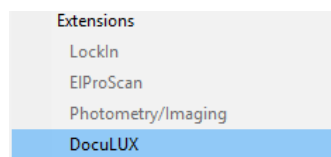


Figure 4.12: The “DocuLUX” event.

The *DocuLUX* event has the following event-specific parameters and features:

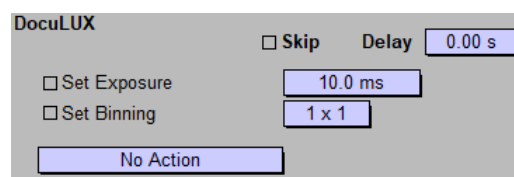


Figure 4.13: Available options of the “DocuLUX” event.

- Set Exposure: Activate the checkbox if the exposure time entered into the entry field should be used for the defined action.
- Set Binning: Activate the checkbox if the binning value selected in the drop-down menu should be used for the defined action.
- Action: This drop-down menu allows to set several different actions:

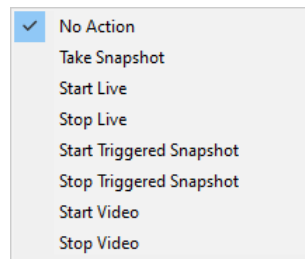


Figure 4.14: Available actions of the “DocuLUX” event.

- No Action: No action will be performed. This would mean no previous action running is altered. However, in this mode you can change e.g. exposure time or the binning value.
- Take Snapshot: With this action you can trigger the acquisition of a single image. The snapshot will be stored in the default path defined in the DOCULUX software. Further, you can alter the name of the snapshot by using the *Filename* entry field. Use the *Set Image Format* option to change the image format of the snapshot independent of the DOCULUX settings.

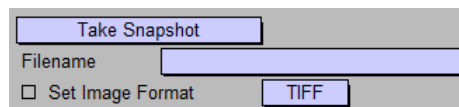


Figure 4.15: Available parameters of the “Take Snapshot” action

- Start Live: Use this action to start the “Live Acquisition” mode of DOCULUX.
- Stop Live: This action stops the “Live Acquisition” mode of DOCULUX.
- Start Triggered Snapshot: Activates the *Triggered Snapshot* option of DOCULUX. DOCULUX is waiting now for a trigger delivered by the trigger cable.

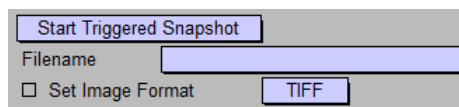


Figure 4.16: Available parameters of the “Start Triggered Snapshot” action

- Stop Triggered Snapshot: Deactivates the *Triggered Snapshot* option of DOCULUX.
- Start Video: This action starts the recording of a video sequence. If necessary, you can alter the name of the video file (*Filename*) different from the settings made in DOCULUX. Further, the frame rate can be defined here (*Frames per Second*). To define the length of the video sequence you need to enter a *Wait* event and another *DocuLUX* event with the *Stop Video* action (see below).

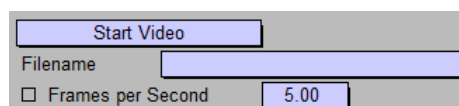


Figure 4.17: Available parameters of the “Start Video” action

```
1: DocuLUX: Action= 2, FPS= 15.000, Path="Moving Macrophage"  
2: Wait: abs 10.00s  
3: DocuLUX: Action= 3,
```

Figure 4.18: Protocol Editor event for starting and stopping a video sequence. “Action=2” = Start Video; “Action=3” = Stop Video. “Wait” event defines the recording length.

- Stop Video: As described before this action is needed to stop the video acquisition.

## 4.2 Using DocuLUX with PATCHMASTER but without Batch Communication

If you are using PATCHMASTER together with one instance of DOCULUX there should be no reason why not using it with the *Batch Communication*. However, if you are using more than one instance of DOCULUX (see chapter 5 on page 47) you need to set up the Pulse Generator sequence or the protocol of the Protocol Editor as described below.

Using PATCHMASTER and DOCULUX without “Batch Communication” means that DOCULUX gets not activated in the Configuration of PATCHMASTER as described in chapter 4.1 on page 28.

In this configuration you do not benefit of the advantages of the *Batch Communication* like linking the images to the data or using the Protocol Editor to define DOCULUX actions.

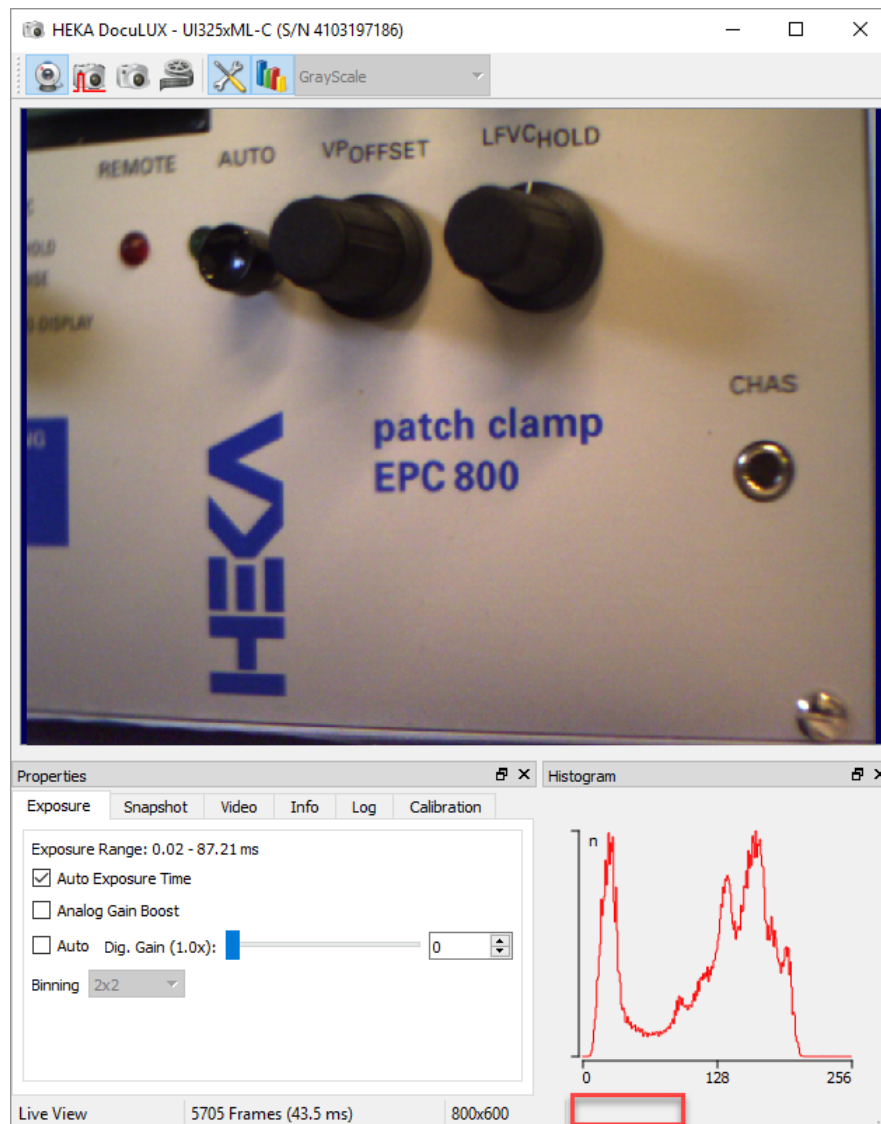


Figure 4.19: Disabled “Batch Communication”.

Another indicator that the “Batch Communication” is disabled is the missing time stamp at the bottom of the Image window of DOCULUX.

### 4.2.1 Using the Pulse Generator

If there is no “Batch Communication” running you need to set up your PGF sequence like you do it for any other external trigger device.

In the following example we assume that we have already a “DocuLUX” stimulation sequence which we used for defining the camera triggers in combination with “Batch Communication”. In addition to that we add another channel which should trigger a second camera. The example works the same way if you have just one camera running without “Batch Communication” but the third channel we create here would be your second channel instead.

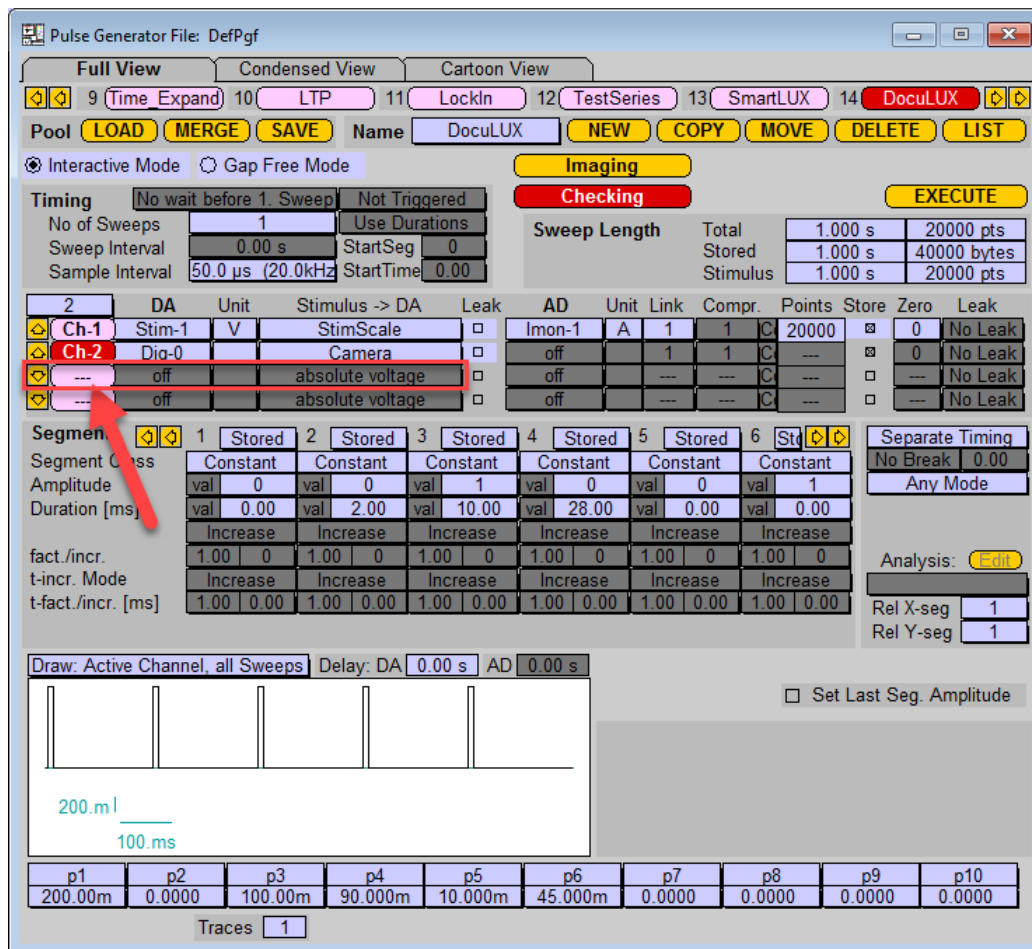


Figure 4.20: PGF sequence with two camera trigger channels. The channel #2 triggers the camera in “Batch Communication” mode. Another channel (#3) will be added to define the triggers for the camera running without “Batch Communication”.

One can only define one output channel as a defined “Camera” channel (see Channel 2). If another output channel needs to be set up as a camera trigger channel its *Stimulus to DA* option needs to be set to “absolute voltage”.

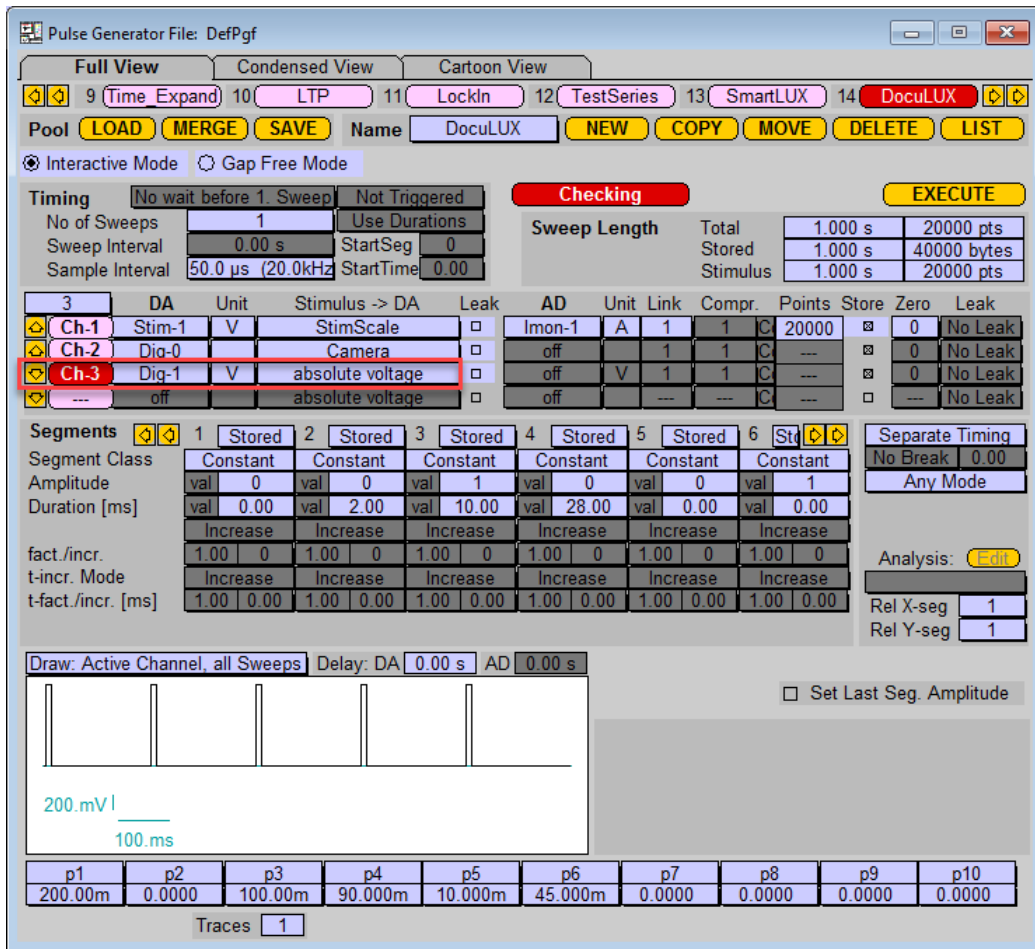


Figure 4.21: Adding an output channel as a trigger channel for the camera.

In the next step one needs to set up the timing in the segments to define the trigger length and the interval time between the output triggers.

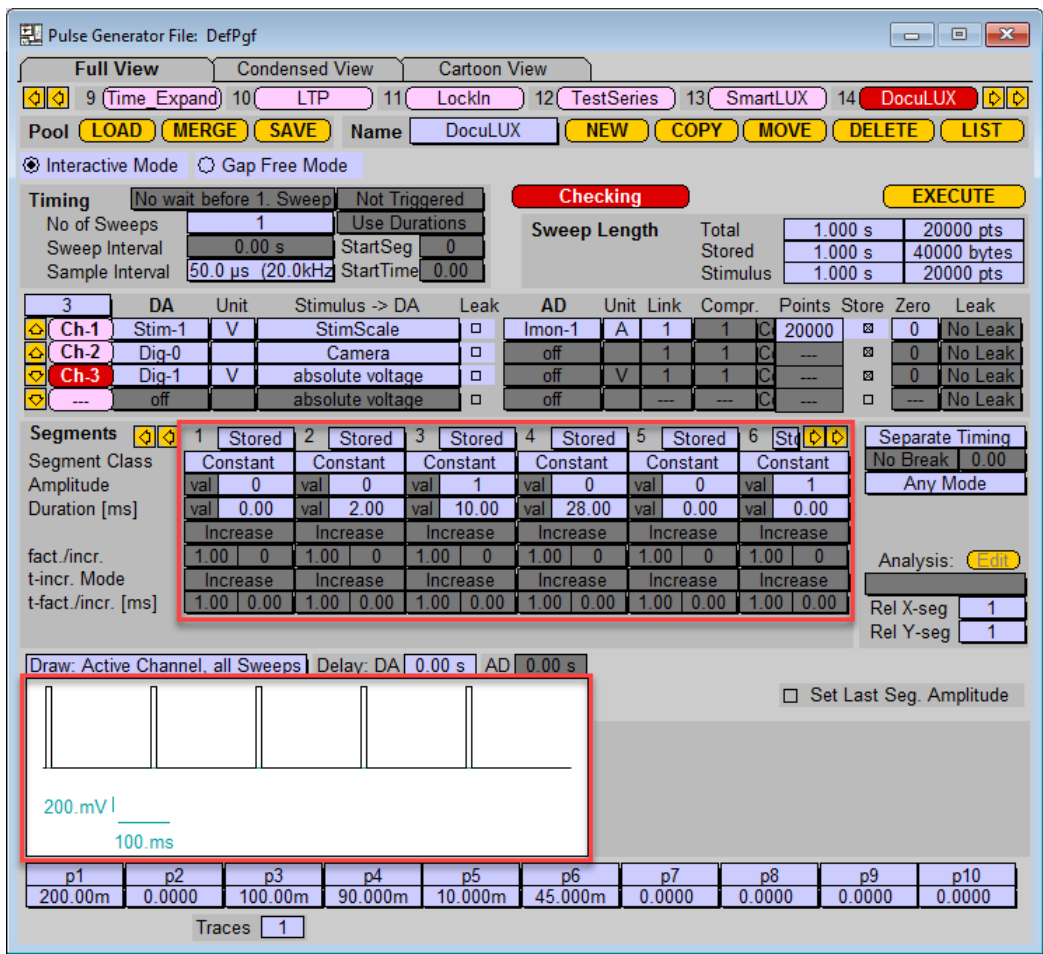


Figure 4.22: Trigger length and interval time definition. Define trigger length and interval time in the segments for the “Channel 3”. Amplitude “0” sets the trigger voltage to “low” level (0 V), Amplitude “1” sets the trigger level to “high” (5 V).

The procedure to set up trigger channels without “Batch Communication” is optional for all other external devices the user wants to control via the HEKA hard- and software.

### 4.2.2 Using the Protocol Editor

In case the DOCULUX extension is not activated in the Configuration of PATCHMASTER but one wants to use the Protocol Editor to send out a trigger to the camera one needs to define the trigger sequence via several event lines in a protocol.

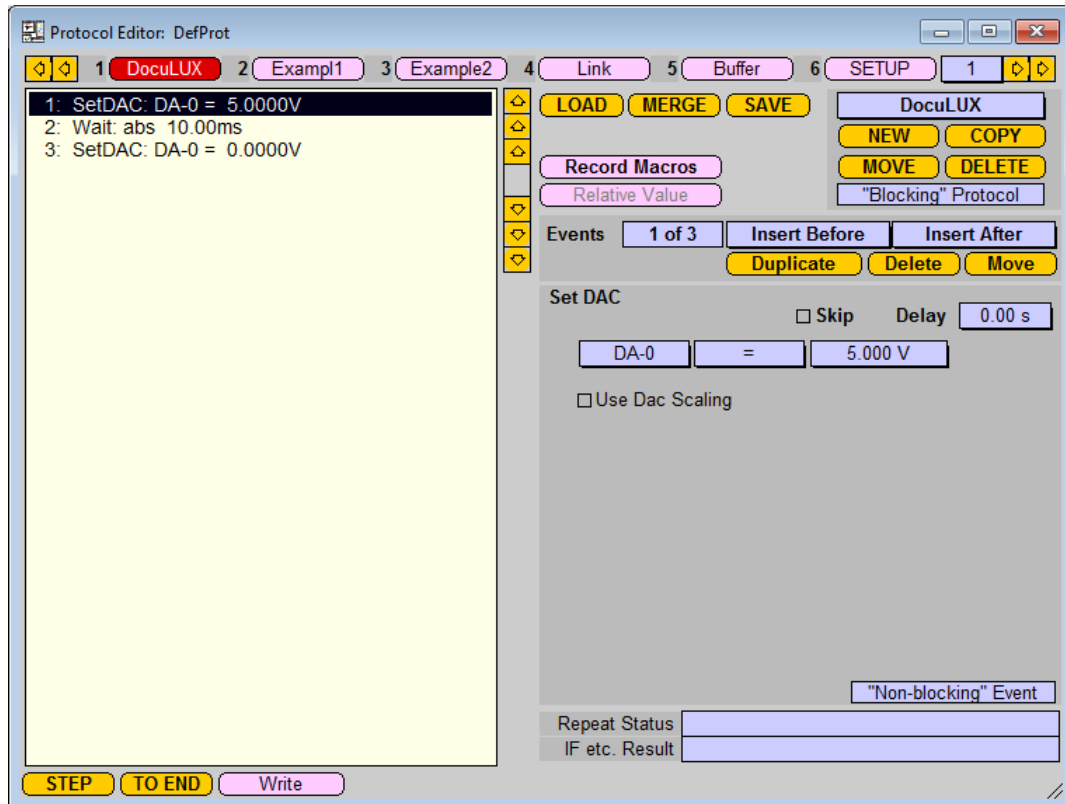


Figure 4.23: Defining a trigger in the Pulse Generator of PATCHMASTER.

One can either use a free analog or digital output of the EPC 10 USB patch clamp amplifier. In addition one needs to set the DOCULUX software to *Triggered Snapshot*.

*Note: In this operating mode you are not able to acquire video sequences or to activate the Live View.*



### 4.3 Using DocuLUX as stand-alone software

The DOCULUX camera system can be easily used in stand-alone mode which means without communicating either with HEKA soft- or hardware. For this usage the `DocuLUX.exe` does not need to be located in the `Patchmaster` folder but can be put anywhere on your computer. Execute the `DocuLUX.exe` and the application starts immediately in *Live View* mode.

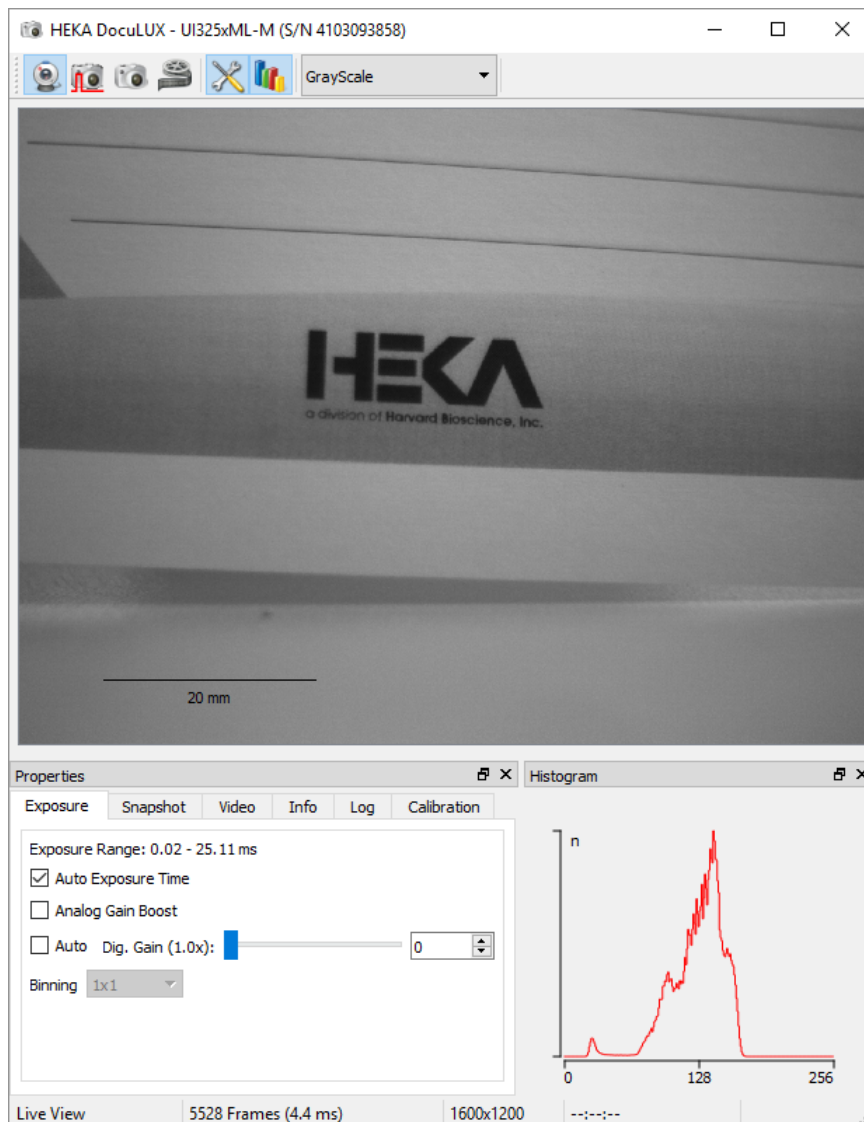


Figure 4.24: Live View mode of DOCULUX.

All functions and options of DOCULUX can be used without restrictions and as described in chapter 3 on page 7.

## 4.4 Using DocuLUX for triggered snapshots with third-party programs

For the acquisition of triggered snapshots there are no special requirements necessary. One just needs to activate the *Triggered Snapshot* (see chapter 3.2 on page 9) and provide a trigger with at least 3.3 V amplitude and 1 ms length to acquire the snapshot.



## 5 Multiple Instances

Only one instance of DOCULUX can run with one instance of PATCHMASTER via *Batch Communication*. In addition to that one can run any number of independent instances of DOCULUX in parallel.

For simplicity we number the different versions of DOCULUX in the following description how to use multiple instances:

- DocuLUX 1: PM with DocuLUX activated (Batch Communication is running with DocuLUX 1)
- DocuLUX 2: Stand-alone application (no Batch Communication running)

The procedure to set up more than one camera, meaning multiple instances of DOCULUX, is as follows:

1. Connect all cameras to your computer.
2. Start PATCHMASTER and activate DOCULUX in the Configuration of PATCHMASTER. The PATCHMASTER instance and this DOCULUX instance are communicating via *Batch Communication*.

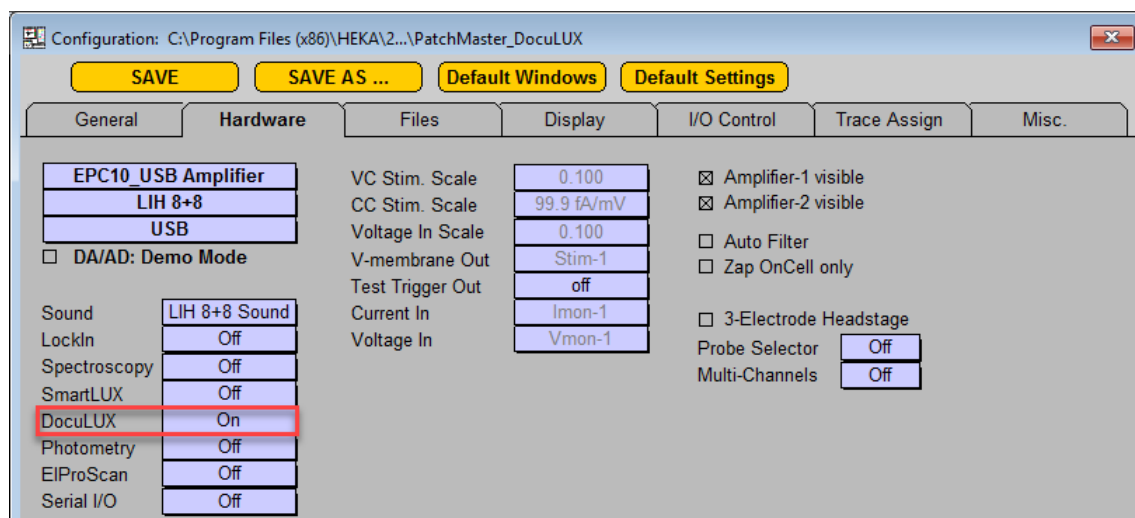


Figure 5.1: Turning on DOCULUX.

3. A camera selection dialog comes up where you need to select the camera which should communication with PATCHMASTER.

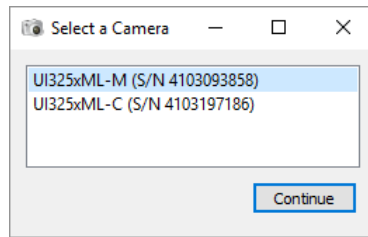


Figure 5.2: Camera selection dialog.

**Note:** If a configuration file was saved while using DOCULUX together with PATCHMASTER and you start with it, the camera which was specified in the configuration will not be listed in the camera selection dialog. Therefore, if you use two cameras, one working with PATCHMASTER and one as a stand-alone application, this dialog will not appear

4. Go to your Patchmaster installation folder and execute "DocuLUX.exe".
5. If there are more than one free available cameras the camera selection dialog (see above) will appear again and you need to define which camera you want to use with this instance.
6. Once you have opened in all your DOCULUX instances in the described procedure you should close PATCHMASTER and all DOCULUX instances.

**Note:** If the configuration was not saved before please save it now.

7. Go to the "Registry Editor" of your operating system and have a look for "HKEY\_CURRENT\_USER - SOFTWARE - HEKA - DocuLUX".

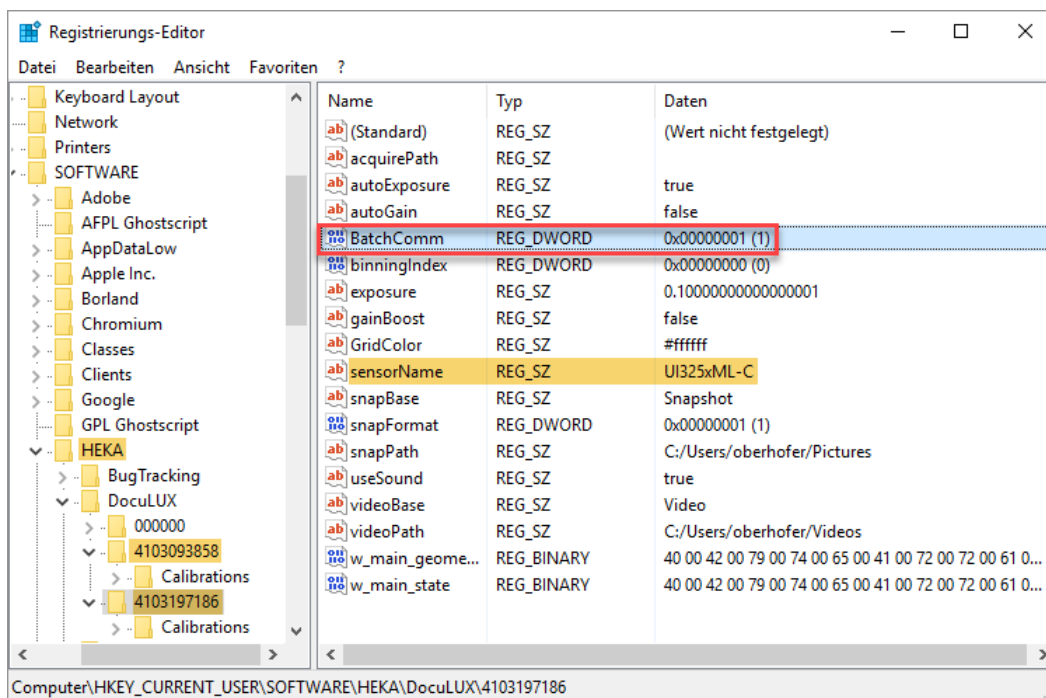


Figure 5.3: Registry Editor of MS Windows 10.

8. Two or more camera serial numbers are listed. Click on the serial numbers to check the parameter sensorName for the camera type. "C" at the end stands for for color, "M" stands for mono camera.
9. Select the camera for DOCULUX2 or other cameras running as stand-alone application and open the parameter BatchComm by double-clicking on it.

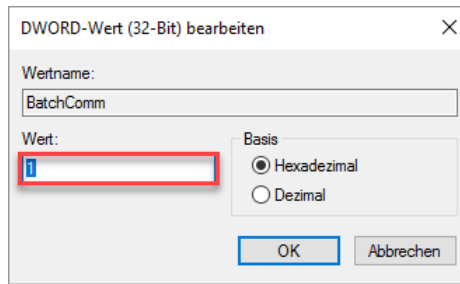


Figure 5.4: Editing the “BatchComm” parameter of the selected camera.

10. Set the value in the upcoming dialog to “0” (0 = no batch communication, 1 = batch communication active).
11. Close the “Registry Editor”.
12. Restart PATCHMASTER
13. Go to your Patchmaster installation folder and execute as many “DocuLUX.exe” instances as needed.

*Please close any running PATCHMASTER and DOCULUX instances before modifying the registry.  
Otherwise any changes there might not be taken over.*

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