HPD-TA - High Performance Digital Temporal Analyzer Ver. 9.4

Users manual

Contents

Introduction

Introduction

This chapter describes provides a first introduction to HPD-TA and it's features.

Legal terms

Introduction

Legal terms

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Security/Precautions

Introduction

Security/Precautions

This chapter deals with the precautions you should observe when handling and operation the devices used in your system. This is of course primarily to avoid risk of dangers related to your live and health (like electrical shock) but also to prevent any damage to the used device (like damage due to overexposure). Please read the following chapters carefully and don 't operate the devices unless you are sure that you are operating them on a save basis.

Precautions of individual devices

Introduction > Security/Precautions

Precautions of individual devices

At first please read the safety instructions of the individual devices. Every device has its own handling manual where its safety precautions are described properly.

Overexposure

Introduction > Security/Precautions

Overexposure

One risk for an operated device is that it might be overexposed, which in certain cases may lead to a damage or even the destruction of the device. Devices which may be damaged during overexposure are Image intensifiers, streak cameras with image intensifier or built in MCP (Micro channel plate), other type of tube cameras and also some kind of CCD cameras at least if they are exposed under special conditions (UV, very strong light etc.).

Display LIVE image while operating the streak camera

Introduction > Security/Precautions

Display LIVE image while operating the streak camera

If you operate your streak camera you should always continuously acquire images with your CCD camera. You also have to make sure that you would observe any strong signal. Therefore it is best to continuously acquire images in Live mode with the maximum available contrast enhancement appropriate for the given case. Pls. see Acquiring images from a camera and Acquisition modes for details.

Exposure time considerations

Introduction > Security/Precautions

Exposure time considerations

A very important topic is also the selected exposure time for the CCD camera. If you start observing images with you CCD camera you should make sure that the CCD camera exposure time is long enough to see enough light. Of course there may be different exposure modes related to the different trigger modes and it is not always very clear with which exposure time and mode the CCD camera is operating and also every CCD camera has a different sensitivity (Please see the chapter CCD Camera control and Selecting measurement parameters for details how to control your CCD camera). An of course for every special setup there are certain limits which should be observed. It is not the task of this chapter to give

explicit values for every given condition. Normally this is a topic which should be covered by the responsible Hamamatsu engineer which makes the installation and the introduction. You should refer to the information given during the introduction. If you are unsure please contact you local Hamamatsu dealer or the engineer who made the installation and introduction.

Emergency!

Introduction > Security/Precautions

Emergency!

If in any case you feel that your system may be irradiated by too much light, you can use the Emergency! function to close the Streak camera shutter, set the MCP gain to 0 and eventually close the spectrographs slit. The Emergency! function can be executed by the function key F8 but it is not operated under certain condition (ex. if an option dialog is currently executed) and it is - of course- only executable if the function of streak shutter, MCP and spectrograph shutter can be controlled by the HPD-TA. This is normally the case if the device is connected by GP-IB or USB. Please see also the chapter Emergency! for details

Auto streak shutter

Introduction > Security/Precautions

Auto streak shutter

If **Auto streak shutter** is selected the streak shutter will be always automatically opened when an acquisition is started and automatically closed when the acquisition ends. This feature can be used to prevent the streak camera of being exposed to incident light when no measurement is under progress.

Auto MCP

Introduction > Security/Precautions

Auto MCP

If **Auto MCP** is selected the MCP gain as previously set by the user will automatically be set when an acquisition is started and automatically set to the minimum value when the acquisition ends. This is also a function which helps to protect the streak tube when no measurement is under process.

CCD cooler / vacuum

Introduction > Security/Precautions

CCD cooler / vacuum

Be also careful to operate the CCD cooler, an option water cooler and an optional vacuum pump in the proper way. Please read the handling instructions of these devices carefully. Also open or close attached valves only in the correct order. Otherwise condensation on the CCD chip or contamination may occur.

Help / Info

Introduction

Help / Info

HPD-TA is designed to offer a user-friendly operation system for these cameras as well as all basic image processing functions needed for routine work. In many cases the user can just guess by the command names and the arrangement of the user I/F controls how a desired

function works.

How do I get more information about this program?

Introduction > Help / Info

How do I get more information about this program?

The following possibilities are available to get more information about this program, what it can do and how this can be achieved.

- A windows help system explains - divided in small easy to understand topics - the program and all its parts
- For those how like to study the feature of this with the help of a printed manual also such a manual is available.

In which circumstances should I read the information in this documentation?

Introduction > Help / Info

In which circumstances should I read the information in this documentation?

- To get started with the digital image processing system.
- To get detailed information about complex operation methods and procedures. Since HPD-TA is a "look and feel" program, you may not need this manual for your daily work. However there are several functions which may not be understood easily by just using the program. We have put priority to explain such items in this manual.

How do I use this help system?

Introduction > Help / Info

How do I use this help system?

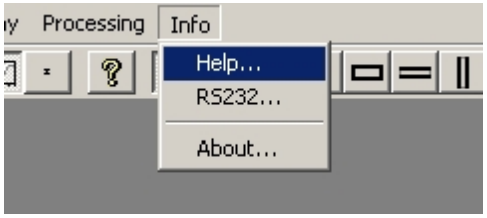
To use this help system simply press F1 from the program or double-click to the Help file from the explorer. The Help system will open the help dialog.

Help

Introduction > Help / Info

Help

The help system can also be invoked by executing the Help menu entry from the Info main menu.



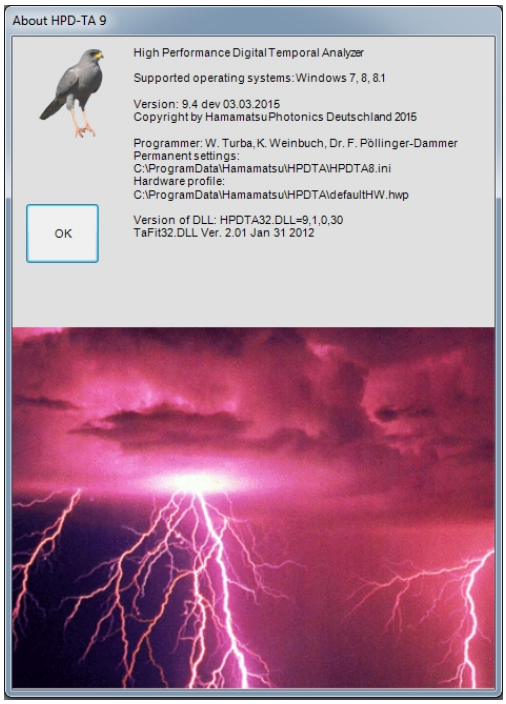
About

Introduction > Help / Info

About

Executing the About menu entry from the Info main menu shows the about Dialog which gives

you information about the current program version and other version related information.



Screenshots in this help system

Introduction > Help / Info

Screenshots in this help system

Screenshots are used extensively to demonstrate the operation and behavior of the program in principle. However, depending on the Operation system, the color scheme and also other setting in your program the program may look like slightly different.

Features

Introduction

Features

This chapter describes the features of HPD-TA.

General

Introduction > Features

General

The **HPD-TA (High Performance Digital Temporal Analyzer) software** is a high-performance digital image processing system designed to read-out images from the phosphor screen of Hamamatsu streak cameras. It enables precise acquisition and quantitative analysis of two-dimensional streak data, including a full range of data correction and calibration functions.

If used in combination with new-generation streak cameras it also provides remote control of all streak camera functions via GPIB and USB interface.

The standard version of the system employs a state-of-the-art high resolution cooled CCD device like the ORCA-R², C9300, Orca Flash 4.0, ORCA-ER or C4880 as an image sensor. With this camera it is possible to use the system also for other purposes, for example for spectrograph readout. Provided that the special features and the performance of a cooled CCD camera are not required the user may also choose another special video CCD.

The camera or sensor is connected to an IBM-compatible PC via a frame grabber board. The board performs tasks like digital image acquisition, pseudo-colour generation or image accumulation.

In order to work with HPD-TA you have to install a hardware lock.

If this is not installed, HPD-TA works in demonstration mode only.

The HPD-TA is available as 32 bit as well as 64 bit application software.

What is new in version 9.4?

Introduction > Features

What is new in version 9.4?

The following features are new or improved in version 9.4 compared to version 9.3:

- The release 9.4 comes with a new application called HiPic/Spectro to deal with spectroscopic data.
- Additionally to the conventional 2-dimensional display of images they can now be displayed in the way of a bird view
- New streaker: support horizontal sweep through RemoteEX, Normalize the intensity to reasonable values
- The C10149 pulse/delay generator is supported
- A right mouse click command "Copy with corrections" allows to provide a completely corrected image (background and shading) from an analog integration image which is still under acquisition.
- A command "Create BirdView image from Sequence" allows to create a two dimensional image from a sequence, where each sequence image contributes a single line.

Hints for users familiar with version 7 or before

Introduction > Features

Hints for users familiar with version 7 or before

Between version 7 and version 8 the whole user interface has been redesigned. Users familiar with older versions (like version 7 or 6) may find several features confusing at the first glance. This is due to the fact that some features have been improved to comply with modern windows standard. Reading the following small chapter may help to resolve this confusing situation.

Options

First of all such users may desperately search for options at well defined locations and cannot find them any more. The solution is simple: All options including the former camera setup parameters have been collected in the options dialog and can be called with the main menu entry **file options** or with a context sensitive menu. Please see also the chapter Basic operations - Options and Selecting Measurement parameters Options in the document.

Right mouse click redefined

Another change was to introduce context sensitive menus with right mouse click. As a consequence the right mouse click which is used to zoom out images is no longer available. There are two solutions for this: Generally speaking all right mouse clicks are replaced by the shift key. In other words zoom out can be done by Shift Key + Left Mouse click. The second solution is to use the context sensitive menu to select the zoom factor directly. Please see also the chapter Context sensitive menus and zoom in this document.

ROIs

The third topic which is very different from earlier versions is how to draw and handle ROIs. The biggest difference is that a new ROI can only be draw when a ROI type is selected in the toolbar. After selecting the ROI this selection is no longer valid thus the ROI cannot be easily overwritten. To draw more then one ROI just select a ROI type again. To select one ROI just click to it and to delete press the delete key. The new ROI types Full horizontal and Full vertical may satisfy the request from many users in the past. Please see also the chapter The Elements of the user I/F - ROIs and Image display Windows ROIsin this document.

Hints for users familiar with version 8

Introduction > Features

Hints for users familiar with version 8

Since version 8 the program has been slightly modified. Version 9 is now a real MDI (multiple document interface) program. The CTRL F6 key is globally used to switch between windows. The arrow keys cannot be used alone due to the same reason. Thus moving or resizing ROIs have to be done with the arrow keys while holding down the CTRL key.

Supported hardware and hardware setup

Introduction

Supported hardware and hardware setup

This chapter describes the supported hardware and the hardware setup process of HPD-TA.

Streak cameras

Introduction > Supported hardware and hardware setup

Streak cameras

The following streak cameras are supported:

C1587, C2830, C5680 (universal streak camera), C3681, C4334 (streak scope), C4187 (framing camera), C6860, C6138, C1370, C3735, C4575, C7700 (high dynamic range streak camera), C2590-01, C9510, C979, C10627 (new streak scope), C10910 (new universal streak camera), C6138 USB (new version of C6138), C4575-03 (X-ray streak camera), C11293 (NIR streak camera)

Image sensors

Introduction > Supported hardware and hardware setup

Image sensors

The HPD-TA supports the following image sensors:

ORCA-R², C9300, Orca Flash 4.0, ORCA-ER, ORCA-II, C4880

Frame Grabber

Introduction > Supported hardware and hardware setup

Frame Grabber

The following frame grabber boards are supported.

Fire Wire A and B

Board	Comment
IEEE 1394 OHCI PCI board	
On board fire wire I/F on desktop or laptop PC	
IOI IEEE 1394B OHCI PCIe board	This is the only one recommended for Fire Wire B cameras (ORCA-R², ORCA-D²)

Camera Link

Board	Company	Bus	Configuration
X64 Xcelera-CL PX4 DUAL	Dalsa	PCIExpress X4	Medium config.
X64 Xcelera-CL LX1 BASE	Dalsa	PCIExpress X1	Base config
X64 Xcelera-CL PX4 FULL	Dalsa	PCIExpress X4	Full config
PC-CamLink	Dalsa	PCI32	Base config
PHOENIX-AS-PHX-D24CL-PCI32B	AS	PCI32	Base config
PHOENIX-AS-PHX-D24CL-PE1	AS	PCIExpress X1	
PHOENIX-AS-PHX-D48CL-PE1	AS	PCIExpress X1	Medium config.
PHOENIX-AS-PHX-D48CL-PE4	AS	PCIExpress X4	Medium config.
PHOENIX-AS-PHX-D64CL-PE4	AS	PCIExpress X4	Full config.
PHOENIX-AS-PHX-D48CL-PCI64	AS	PCI64	Medium config.
PCI-1426	NI	PCI32	Base config
PCI-1428	NI	PCI32	Base config
X64-iPro Light	Dalsa	PCI64/ PCI32	Base config
X64-Full	Dalsa	PCI64/ PCI32	Full config.
microEnable IV VD4 microEnable IV AD4	Silicon Software	PCIExpress X4	Full config. + 10 Tap mode (DECA mode)
microEnable IV VD1 microEnable IV AD1	Silicon Software	PCIExpress X1	Full config

Notes:
AS: Active Silicon
NI: National Instruments
The PCCamLink is discontinued

RS422/LVDS

Board	Company	Bus	Comment
PHOENIX-AS-PHX-D36-PCI32	AS	PCI32	LVDS only (but works with RS422 as well)
PHOENIX-AS-PHX-D36-PE1	AS	PCIExpress X1	LVDS only (but works with RS422 as well)
PCI 1422	NI	PCI32	LVDS or RS422
PCI 1424	NI	PCI32	LVDS or RS422
X64 XCelera LVDS	Dalsa	PCIExpress X4	LVDS only (but works with RS422 as well)
PC-DIG	Coreco/ Dalsa	PCI32	Exists in RS422 or LVDS version

The following grabbers are discontinued:
PC-DIG (Dalsa)
PHOENIX-AS-PHX-D36-PCI64 (AS)
PC-CamLink (Dalsa)

Limitations on 64 Bit operating systems

Introduction > Supported hardware and hardware setup

Limitations on 64 Bit operating systems

The 32 bit software can be used on 64 bit operating systems as well. The 64 bit software can be used on 64 bit operating systems only. Not all hardware components can work in all configurations. Please see the following table or ask Hamamatsu.

Hardware	Win 7 32Bit / 32Bit HPD-TA	Win 7 64Bit / 32Bit HPD-TA (so called WOW64)	Win 7 64Bit / 64Bit HPD-TA
Coreco IC-PCI/AM-VS, IC-PCI/AM-DIG	-	-	-
Dalsa PC-DIG, PC-Vision, PC-CamLink, PC-Vision PCI	X	-	-
AS Phoenix LVDS Pe1	X	X	X
AS Phoenix CL PCI32	X	-	-
AS Phoenix CL Pe1, Pe4	X	X	X
Dalsa X64 XCelera PX4 DUAL/FULL, Dalsa X64 XCelera LX1 BASE	X	-	X
PC-2Vision PCIe	X	-	X
NI PCI 1422, 1424	X	-	-
Keithley KPCI 488, 488LP	-	-	-
NI 488 (GP-IB) PCI32	X	X	X
NI 488 (GP-IB) PCIe	X	X	X
IEEE 1394a and b (fire wire) PCI32	X	-	-
IEEE 1394a and b (fire wire) PCIe	X	X	X
C10627, C1097-05, C10910	X	X	X
C6138 USB version, C4575-03	X	-	-
Computer boards CTR-05 PCI	X	-	-

Spectrographs

Introduction > Supported hardware and hardware setup

Spectrographs

The following spectrographs are supported in HPD-TA:

Chromex 250, Chromex 500, SpectraPro, SpectraPro (USB), Bruker 250IS, Bruker 500IS, Insight H, IsoPlane

Delay generators

Introduction > Supported hardware and hardware setup

Delay generators

The following delay generators are supported in HPD-TA:

DG535, C1097-01, C4792-01, C4792-01L, C4398-01, C6878, C4792-01X, C1097-05, DG645 (with GP-IB, RS232 and Ethernet), C10647-01, T560, C12270, C10149

Other interface devices

Introduction > Supported hardware and hardware setup

Other interface devices

The following other interface devices are supported:

CTR 05 (Counter Timer Board)

National Instruments boards, Keithley KPCI488 or KPCI488LP (GP-IB)

A6538 (Shutter adapter for Absorption Measurements)

Required Computer

Introduction > Supported hardware and hardware setup

Required Computer

Any state of the art PC with Windows 7, 8 of 8.1 can be used to operate HPD-TA.

Be careful that the PC has enough free slots to place the required interface boards. A parallel port or USB port is required for the hardware lock. Please also make sure that slots are suitable to contain the interface boards, for example not all PCI Express slots support PX4. In rare cases the computer is incompatible with the interfaced boards. It is out of control of Hamamatsu to ensure compatibility in all cases and Hamamatsu cannot be made liable for such problems even though we try to do everything to avoid any problem. If large images have to be viewed a large monitor is advantageous.

Internal driver and DCAM driver

Introduction > Supported hardware and hardware setup

Internal driver and DCAM driver

To understand which cameras or more precisely speaking which combinations of cameras and frame grabbers are supported we have to know that there are two methods of interfacing the camera/frame grabber:

- Internal driver (using software modules written together with the main application)
- DCAM API (using software modules provided by the manufacturer, Hamamatsu KK Japan)

Many combinations of cameras/frame grabber are supported using both methods. However there are combinations of cameras/grabbers which are only supported by one of these

methods. The following is an overview of hardware supported by internal drivers. To find out which cameras/grabbers are supported by DCAM please see the release notes on the DCAM section of your distribution CD or consult the following website.

http://www.dcamapi.com/

In almost all cases you do not need to know about this selection because it is done very easily with the Using the Select new camera Assistantfunction.

Triggering schemes

Introduction > Supported hardware and hardware setup

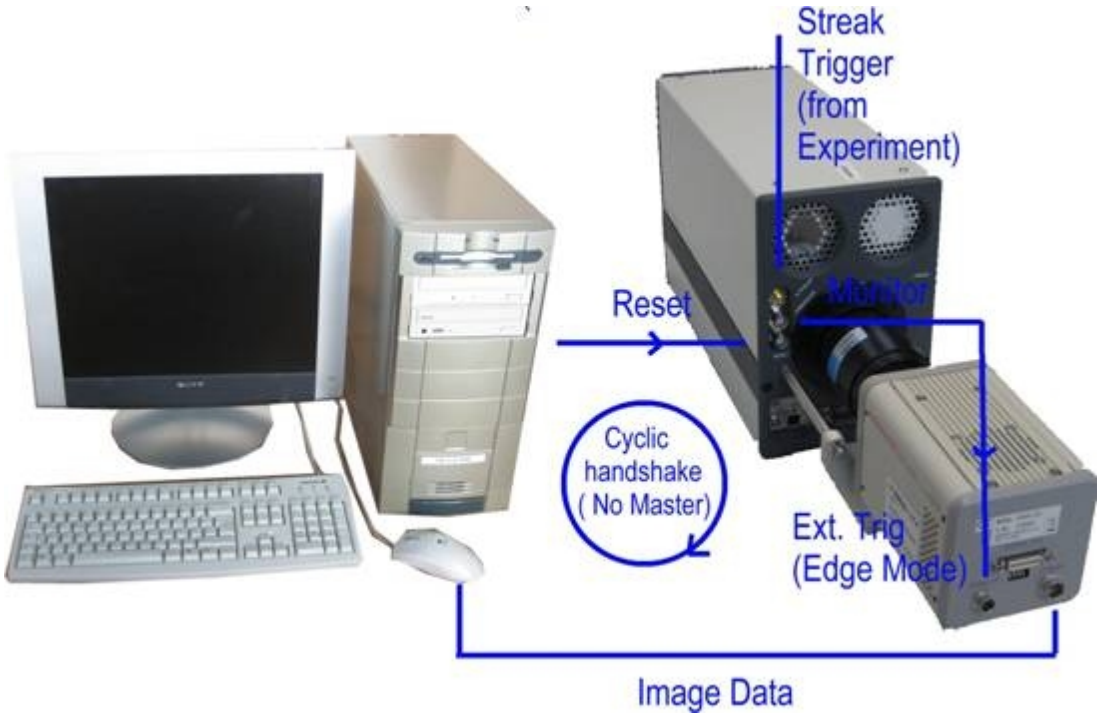
Triggering schemes

It is not the task of this manual to explain all possible combinations of devices and connections which can be done in principle. If there is a doubt about how make all cable connections between the individual devices please consult Hamamatsu. This chapter explains in principle the way how the individual units can interact and which methods there are in principle. Once understood the principle it is less difficult to figure out how to connect the units and how to setup the correct options in the software.

Sequential trigger

Introduction > Supported hardware and hardware setup > Triggering schemes

Sequential trigger

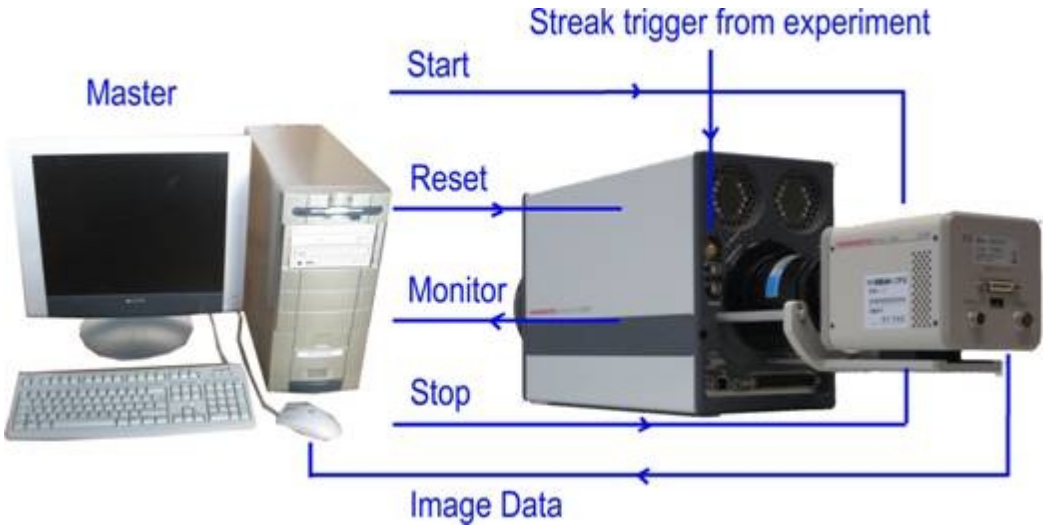


In Sequential trigger mode the experiment triggers the streak camera, the streak camera s Monitor out signal triggers the CCD camera which is operated in an external trigger mode. The software initiates this by resetting the streak camera and then waiting for the CCD camera image to be outputted. This is the most common triggering method.

Enclosing trigger

Introduction > Supported hardware and hardware setup > Triggering schemes

Enclosing trigger

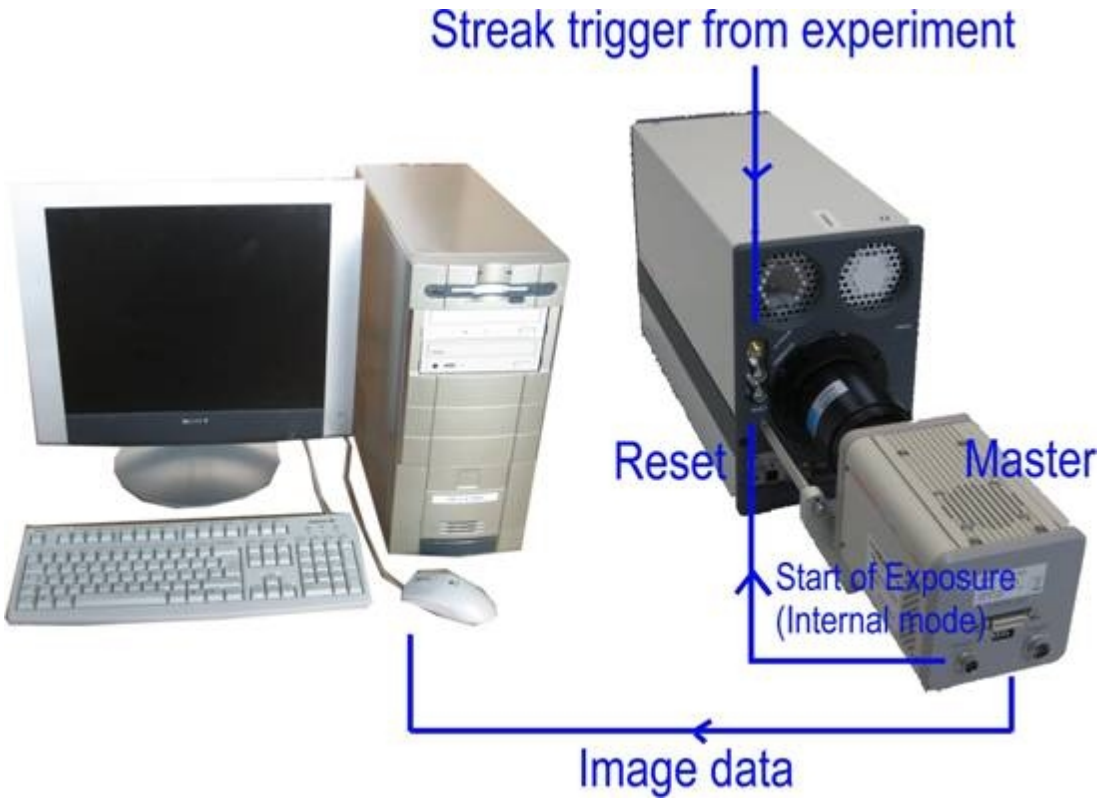


The Software starts the Exposure at the CCD camera, then sends a reset pulse to the streak camera, which is triggered by the next trigger from the experiment. As soon as the Monitor pulse from the streak camera is detected either a new reset pulse can be sent (this enables multiple triggers on the same CCD camera image with high frequency) or the CCD camera image acquisition is stopped and the image readout.

CCD master

Introduction > Supported hardware and hardware setup > Triggering schemes

CCD master

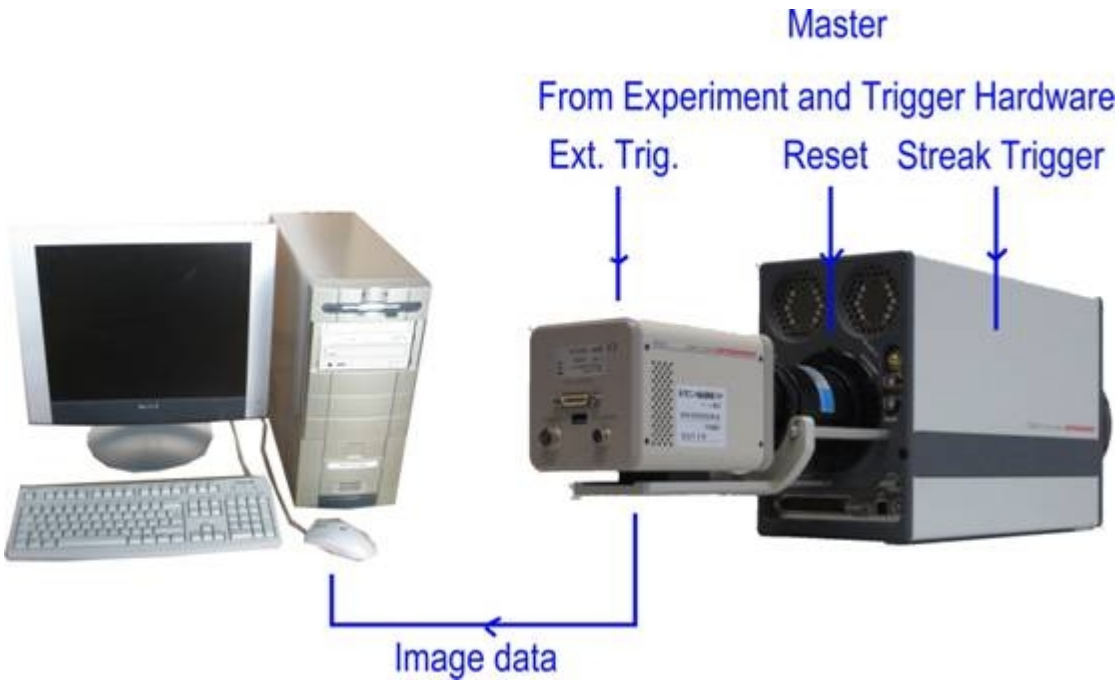


In this mode the CCD camera runs in internal mode. A signal from the CCD camera controls the Reset input of the streak camera. This mode enables very easy synchronization of streak camera and CCD camera with high repetition rate without individual software interaction. It does not ensure individual trigger handshake.

The Experiment has full control of all triggered devices

Introduction > Supported hardware and hardware setup > Triggering schemes

The Experiment has full control of all triggered devices



In this method all triggers are produces by the experiment. The software needs to set all devices to the correct mode only.

Not synchronized

Introduction > Supported hardware and hardware setup > Triggering schemes

Not synchronized

Besides the possibilities to synchronize the individual devices there is of course a possibility to operate the devices in a not synchronized way. This is especially the case if a synchroscan streak camera or a single sweep with high repetition rate is used.

Installation

Introduction

Installation

This chapter describes the hardware configuration, set-up and software installation of the HPD-TA system. If your system was already pre-installed by Hamamatsu you do not need to read his chapter.

Note: Please install the software at first and install the hardware in a second step.

Setup launcher

Introduction > Installation

Setup launcher

HPD-TA software is delivered on a CD.

Note: You should install the plugin boards like frame grabbers or IEEE1394 adapters into your computer **after** the software installation is completed.

Start Windows 7, 8 or 8.1.

Insert the CD into you CD drive. The installation program will normally be started automatically by an autostart routine.

If it does not run automatically, select "**Run**" from the "**Start**" menu and type **D:\Setup** then click **"OK"** (assuming that your CD drive has the drive letter D:) or select the directory **D:** and double click on the file Setup.exe.

The set-up program will start displaying the setup launcher dialog.

The setup launcher is a collection of setup programs from Hamamatsu and third parties to install the main program, several drivers and other utilities.

Notes: Please make sure that elder versions of all programs/drivers and utilities are uninstalled before the new version is installed.

Please collect information about the camera type and interface type (grabber, IEEE1394 etc.) before you start the installation.

Program installation

Introduction > Installation

Program installation

Start with the program installation by pressing the **1.HPD-TA Program** button.

Follow the instructions displayed on the screen.

After installation of the HPD-TA you will find the following three icons on the desktop:

HPD-TA Main program

HPD-TA RemoteEx program

Installing the 64 Bit Version

Introduction > Installation

Installing the 64 Bit Version

On a 64 bit operating system also the 64 bit version of the software can be installed. This will take full advantage of the features of a 64 bit system. The 32 bit software, however, can also run on a 64 bit system and can be installed in parallel.

Hardware lock

Introduction > Installation

Hardware lock

The software is protected by a hardware lock. Install the drivers of the hardware lock by clicking to **2. Hardware protection**

Note: In earlier version of this program it was required to install the sentinel protection server to operate the program in a Microsoft Remote desktop (RDP) session. From version 9.3 pf4 this is no longer necessary.

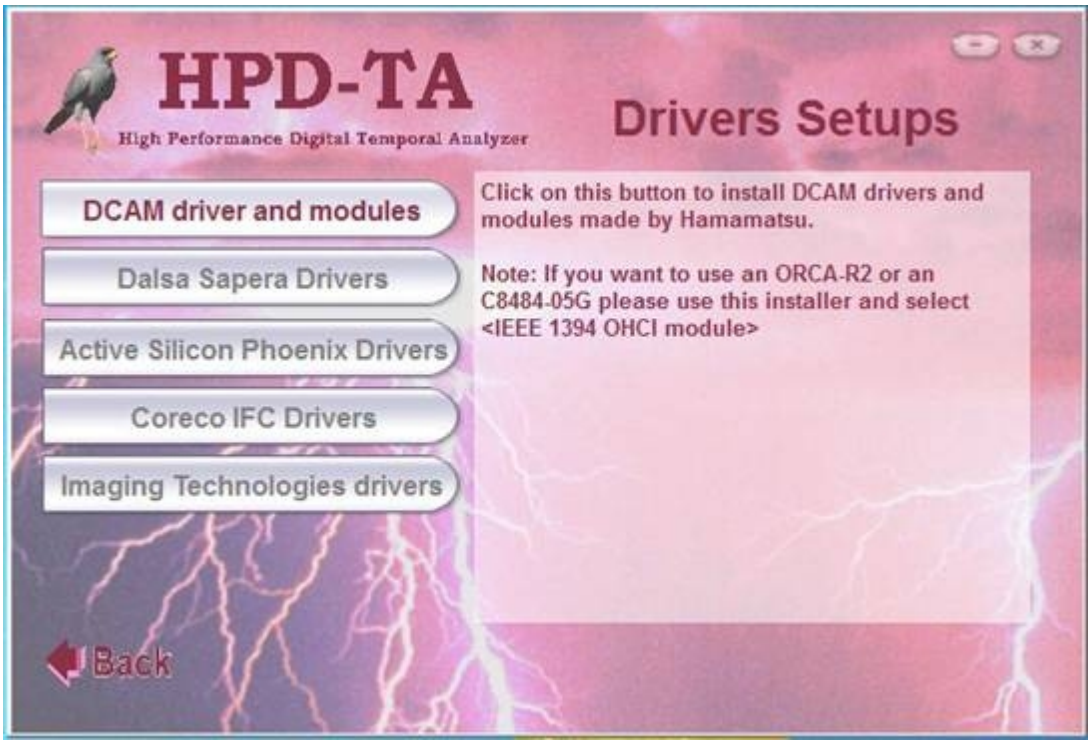
When installing the driver for the dongle from the Setup launcher the sentinel protection server is not installed and it is not recommended to do so.

Driver Installation

Introduction > Installation

Driver Installation

Install all necessary drivers to operate the additional hardware by clicking to **3. Drivers**and select the drivers you need.



After completion of the installation you have to re-boot your system.

Other devices

Other devices

Install all drivers for the additional devices by clicking to **4. Other devices**and select the devices you need.

Hardware installation

Hardware installation

Proceed with following steps to install the hardware of your HPD-TA system

Step 1: Install the frame grabber, IEEE1394 or USB3 interface board in your computer.

Step 1: Install the frame grabber, IEEE1394 or USB3 interface board in your computer.

Be sure to install the frame grabber / IEEE1394 / USB3 board in a suitable slot. Disconnect the computer from power and open the computer. Handle these boards with precaution. Be sure that such work is done by authorized personal only.

Step 2: Install the software protection.

Step 2: Install the software protection.

Connect the hardware lock (this is a 25 pin connector labeled with the name of the program or a USB stick type) to the parallel port (LPT1) or an USB port of your computer. The hardware lock is delivered with the HPD-TA program disk.

Step 3: Make the cable connections

Step 3: Make the cable connections

- Connect all cables of your computer (AC cable, keyboard, mouse, monitor etc.)
- Connect all AC line cables of your other devices.
- Connect the camera to the input connector of the frame gabber board.
- Connect the camera head to the camera controller.
- Connect the water cooler (in case of a water cooled camera type).
- If you use a CTR05 counter/timer board: Start the Instacal Utility and configure the board. The board ID configured in this utility has to be set in the Device control setup. See chapter Changing streak camera and other peripheral devices settings.
- Connect the Trigger/Status Adapter to the counter/timer board with the appropriate cable (37 pin D-Sub cable for the CTR05).
- Connect the Status cable if a status port is available for the streak camera.
- Connect the Monitor Out and Reset cable in case a single-shot streak camera is used.
- Set-up the streak camera, the other devices and your optical set-up.
- Mount the ORCA-R^2, C9300, Orca Flash 4.0, ORCA-ER or the C4880 camera on the streak camera mount table. If an analog video camera is used it is normally already installed in the streak camera
  Note: We recommend connecting an objective lens to your camera and looking at ordinary images to get the first images with the HPD-TA program. This allows you to get experience with the readout camera before you operate the complete streak

system.

- If you use the Keithley GPIB board: Set it to the desired base address (default setting is 696 = 2B8Hex) and install it into your computer. Connect all GPIB devices to the board and remember their primary addresses.

Changing/Selecting different hardware from the intro screen.

Introduction > Installation

Changing/Selecting different hardware from the intro screen.

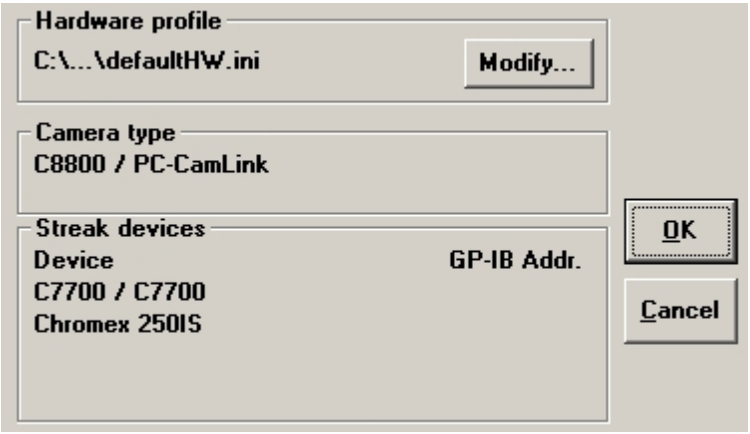
Normally the correct access mode (internal driver/DCAM API), the frame grabber and the camera selection are done by a Hamamatsu engineer during installation. Only in seldom cases - like if you selected a wrong camera model or if you want to change it later - you have to change it after you started the program but before you start the program finally by clicking OK.

Selecting hardware profiles

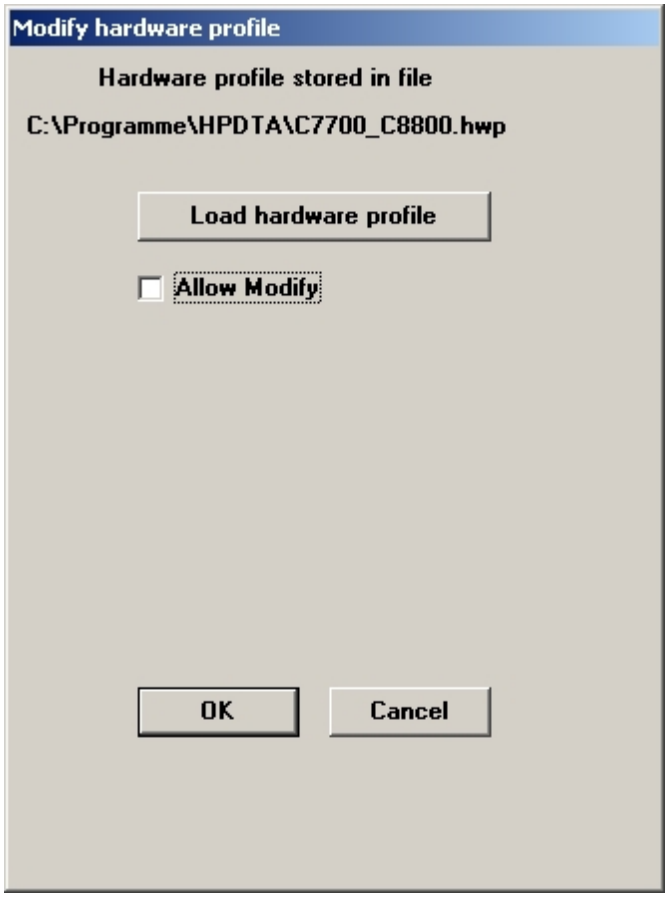
Introduction > Installation > Changing/Selecting different hardware from the intro screen.

Selecting hardware profiles

The HPD-TA allows loading predefined sets of CCD camera selection, streak camera and other devices selection and the related scaling settings. These settings are stored in so called hardware profiles. To change to a new hardware profile click to the Modify pushbutton of the intro screen.



Then a dialog appears which allows selecting another hardware profile by clicking to the pushbutton Load hardware profile .

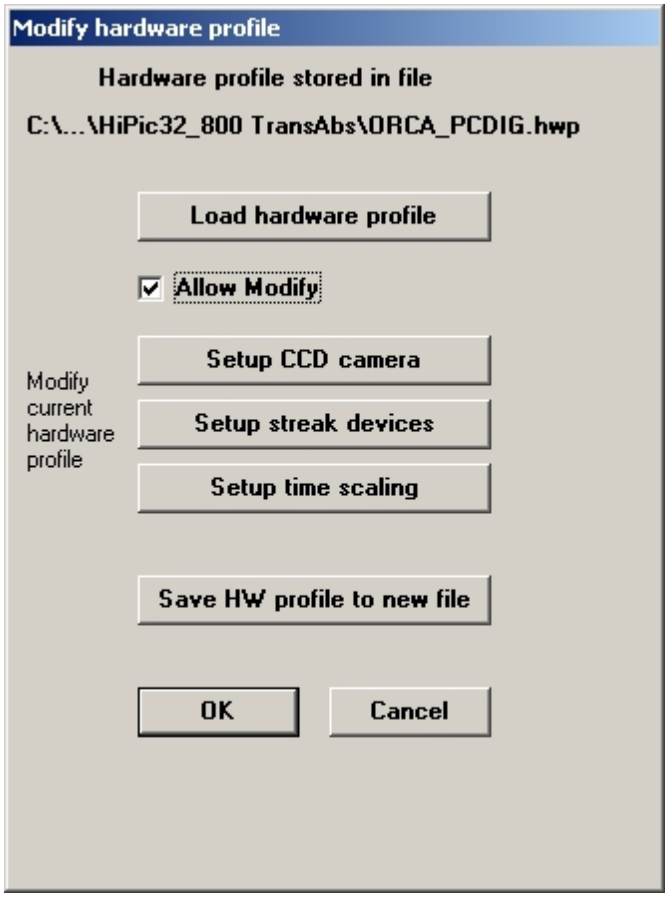


Changing details in the hardware selection

Introduction > Installation > Changing/Selecting different hardware from the intro screen.

Changing details in the hardware selection

To avoid erroneous changes in the setting of access mode, camera or frame grabber selection, the way to change it is hidden as a default. So if you are not familiar with hardware modification do not change any of these parameters! It may result in malfunction of the complete system. To make modifications of details of the hardware you first have to select the checkbox Allow modify . Several controls to make modifications of special settings will now appear.



If you intend to create a new hardware profile you have to click to Save HW profile to new file **now**.

If you want to modify the settings of the current hardware profile file you can now go ahead to make your modification.

Warning: If you are not really familiar with modifying hardware parameters it is highly recommended to use the Save HW profile to new file to create a new file and not modify the existing predefined file. If something goes wrong you still can switch back to the previous hardware profile if it has not been modified.

If you click to Cancel the content of the original file is restored to its original values and it is selected again. So if you are unsure clicking cancel preserves the old hardware settings. Click to OK confirms the selection.

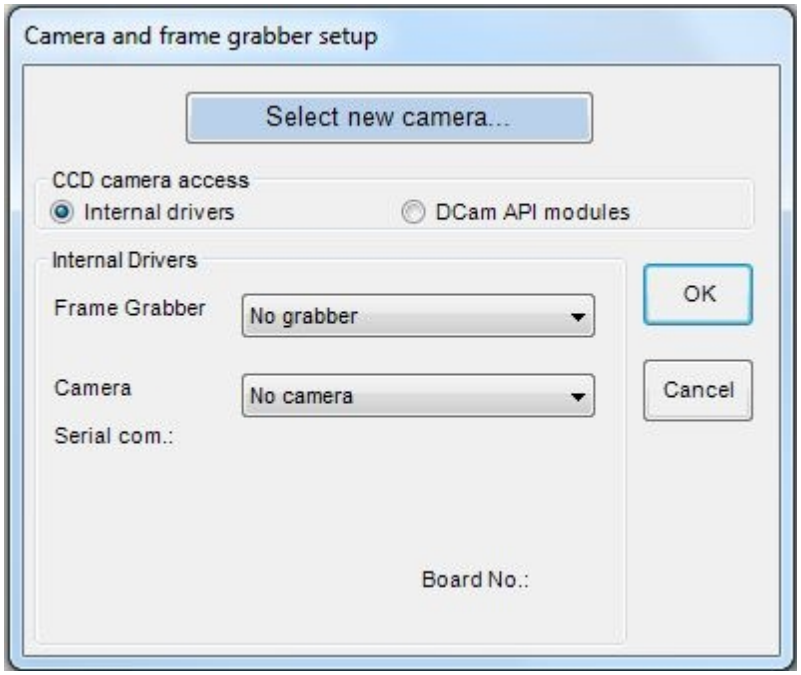
Note: Other files created or modified during this process (others than the file which was select when this dialog has been called) can be modified and will not be restored to its initial values when you call Cancel.

Changing CCD camera settings from a list

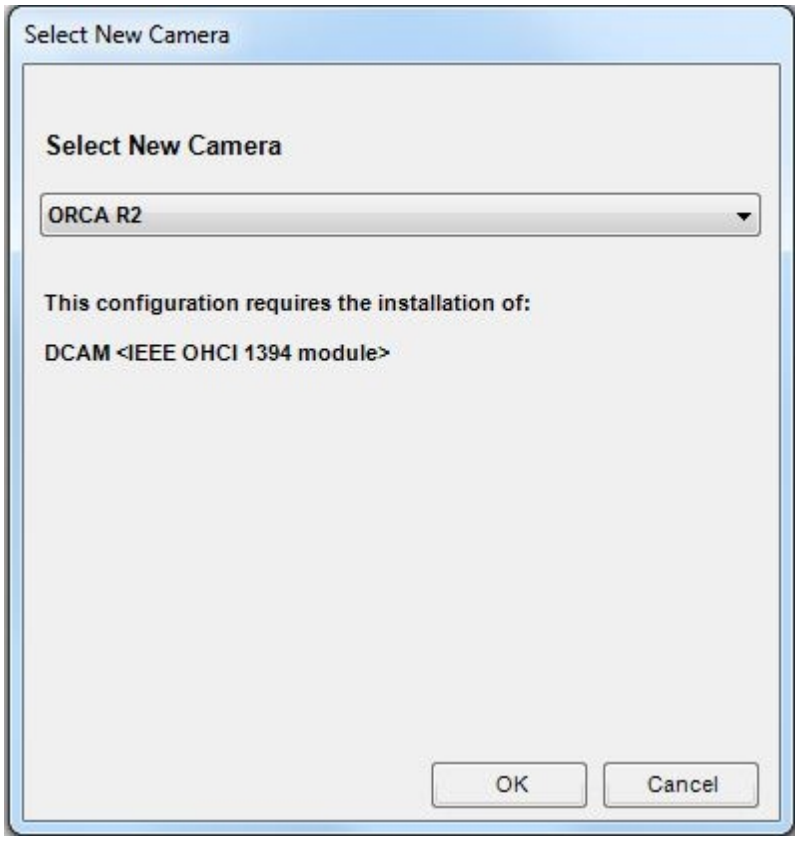
Introduction > Installation > Changing/Selecting different hardware from the intro screen.

Changing CCD camera settings from a list

To change any parameters of the CCD camera click to Setup CCD camera. The Camera and frame grabber setup dialog will appear



The easiest way to select a new CCD camera is to click to Select new camera and select the correct model. You will get an instruction of what you should install additionally:



In some cases I we have do add some special settings. This is the case if we need to specify:

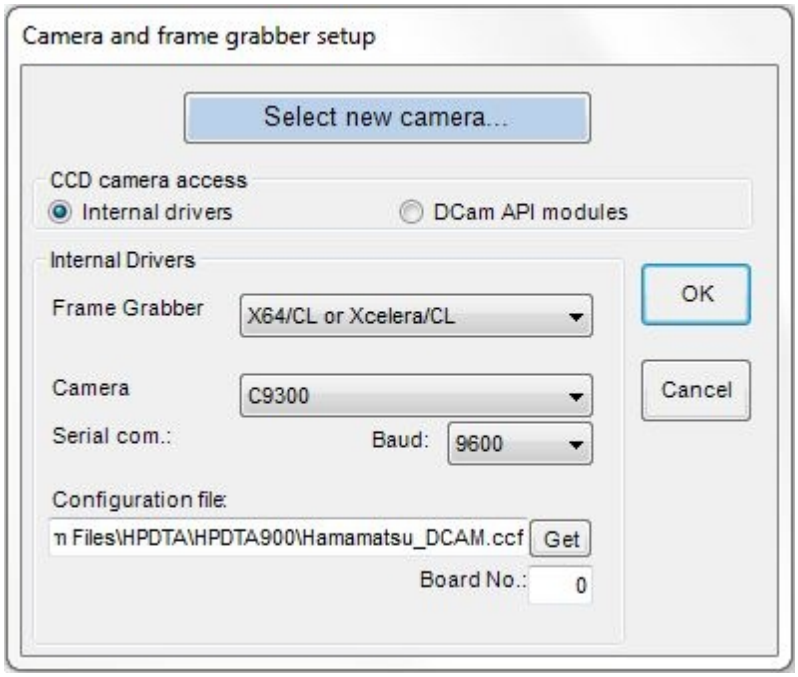
- ††††† A COM Port number
- ††††† A special COM port baud rate (different from 9600 baud)
- ††††† A system number not equal to 0. This is the case if you have installed several board of the same type or supported with the same library.
- ††††† If several cameras are supported through DCAM at a time you may need to select

the correct model number.

Entering CCD camera setting directly

Entering CCD camera setting directly

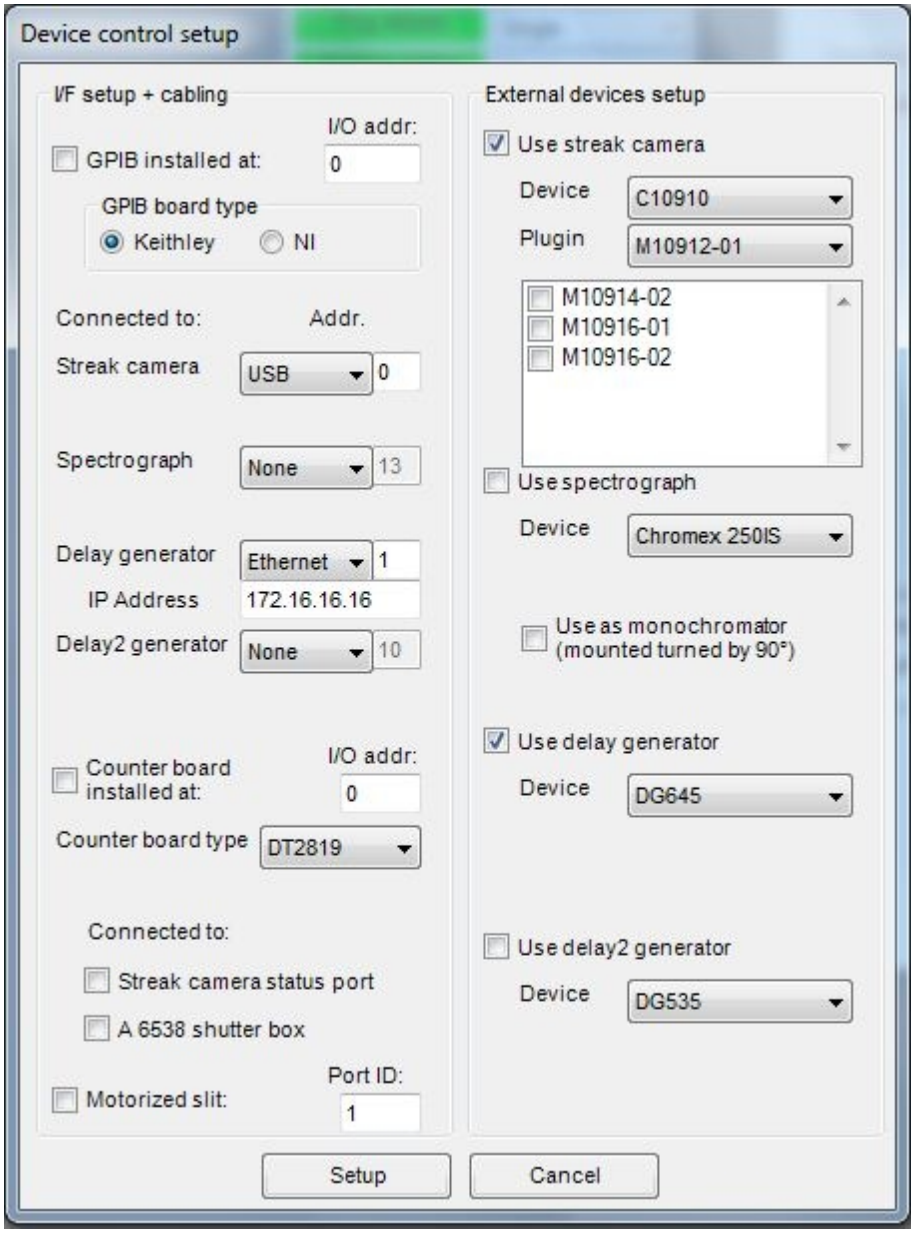
In special cases you may also directly select the grabber, camera, configuration file and system number directly or select the DCAM interface to connet a camera:



Changing streak camera and other peripheral devices settings

Changing streak camera and other peripheral devices settings

Click Setup streak devices from the Modify hardware profile dialog. The device control setup dialog will appear.



Device Control Setup dialog

The streak camera set-up tells the system about the type and configuration of the connected streak camera and other peripheral devices and how they are connected to the system.

Note: It is important that the device control setup is done correctly before you try to operate external devices. If you are unsure please consult Hamamatsu.

Note: Device control setup is rarely modified and it is automatically saved/restored between HPD-TA sessions.

Warning: Please do not modify any of these settings if you are not familiar with the precise meaning of these settings.

HPD-TA allows connecting any Hamamatsu streak camera and other peripheral devices such as spectrographs and delay generators. Some Hamamatsu streak cameras have a 16 bit digital port called status connector which can be read to get information about the internal streak camera status, like time range etc. Some Hamamatsu streak cameras can be

controlled by a GPIB, RS232, USB or Ethernet interface and the status can be inquired via the same interface. Single shot streak cameras have "trigger in", "monitor out" and "reset" connectors (normally BNC connectors) to perform a sophisticated trigger handshake which is fully supported by the HPD-TA. Other peripheral devices such as spectrographs and delay generators can also be controlled by GPIB, RS232 or USB. A GPIB board performs the communication with GPIB controllable devices (streak camera and/or other devices). For trigger handshake (synchronization of streak camera and CCD camera) a counter/timer board can be used.

The device control set-up dialogue has two main sections. A section **I/F setup + cabling** and **External devices setup**.

In the section **I/F setup + cabling** settings about the interface boards which may be plugged into the computer, I/O base addresses and about devices which are connected can be made.

There are three boards which can be used together with **HPD-TA**: The Keithley GPIB board PC-488, the CTR05 trigger/counter board and the Data Translation Counter/Timer board DT2819. The default I/O address of the DT2819 is 560 decimal (230 Hex) and the default I/O address of the PC 488 is 696 decimal (2B8 Hex). These addresses should always be entered in decimal values. Instead of entering 696 for the PC 488, 0 can be specified to indicate the default setting. (This is **not** true for the DT2819).

The CTR05 board ID has to be set (normally to 0). This is the board number which is assigned to this board with the Instacal software (Delivered together with the board).

For GP-IB devices the GPIB address has to be specified. In case of USB device most USB devices assign a virtual COM port number (can be verified in the windows device manager). If so, this COM port number has to be specified as the address.

The section **External devices setup** tells the system which device types should be used and which devices and options are installed on these devices. Only one device of every device type (streak camera, spectrograph, delay unit) can be used at a time.

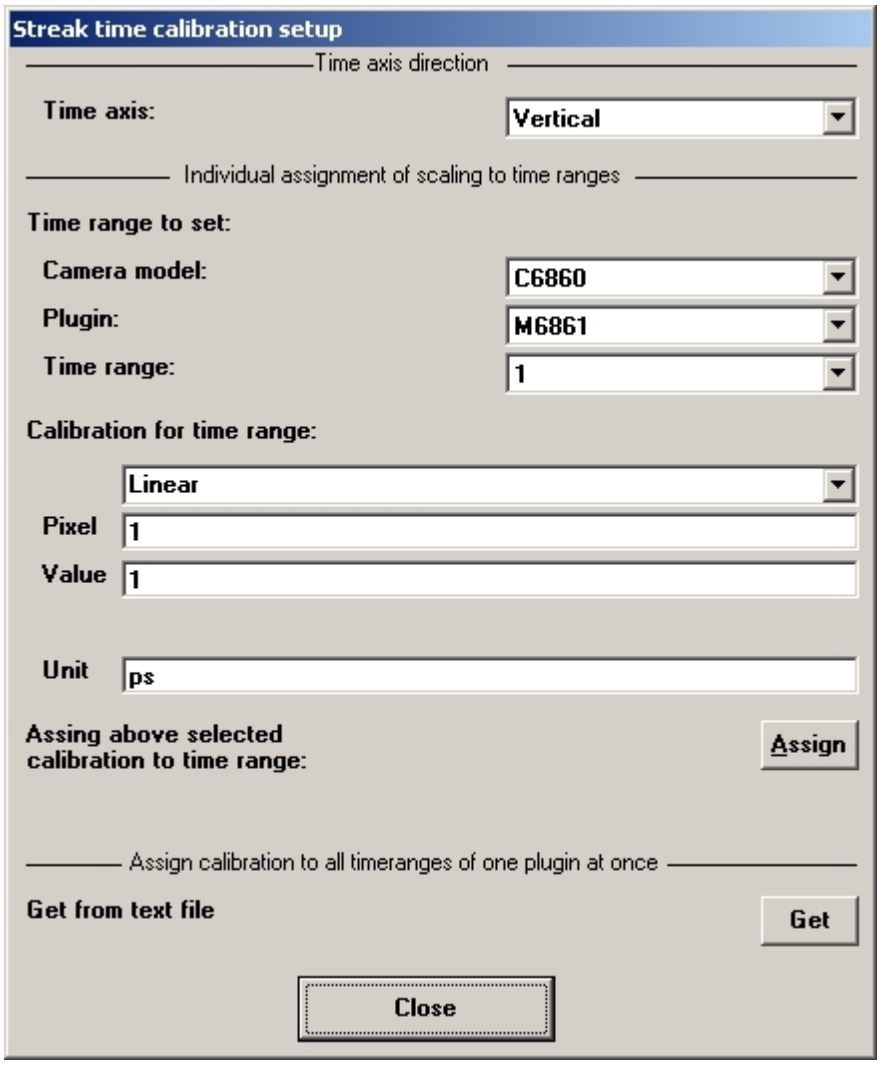
During start-up the program checks the entries and builds a **status/control box** for every device which is used. If there should be inconsistencies within the settings (e.g. if you specify that a GPIB cable is connected to a streak camera which does not have a GPIB interface) an error message will appear.

Entering/Changing Time calibration

Introduction > Installation > Changing/Selecting different hardware from the intro screen.

Entering/Changing Time calibration

Click Setup time scaling from the Modify hardware profile dialog. The Streak camera time scaling setup dialog will appear.



Streak Time scaling

First you have to select which axis should be the axis for the streak sweep. In almost all cases this is the vertical axis.

Then you can specify one set of scaling data for each time range. You can attach scaling information to different time ranges of several sweep plug-ins and even several streak cameras. You can specify up to 100 such entries. These entries are automatically saved in the hardware profile file and loaded when the system is started again.

Select the time range to which you want to attach scaling information by selecting the correct entries from the three combo boxes **Camera model**, **Plugin** and **Time range** within the frame **Time range to set**. If there is already a valid scaling assignment you will see the values in the frame **Scaling for time range**. You can use this feature to easily check the correct scaling for every time range of your streak camera. Then enter the values within the frame **Scaling for time range** as described in detail in the section Entering/Changing Time calibration. If everything is correct confirm the assignment by clicking **Assign Scaling**.

Note: You have to click **Assign Scaling** for each time range.

Get from Text file

Introduction > Installation > Changing/Selecting different hardware from the intro screen.

Get from Text file

If you press **Get from text file** you can load the scaling data from a text file which may e.g. be provided with your streak camera. An example of a file is shown below:

480 *1
C1587 *2
M1954 *3
1,ps,2,7.3077e-01, -5.0153e-05,7.7551e-08 *4
2,ps,2,1.2818e+00, -3.7142e-04,6.8962e-07
3,ps,2,2.4039e+00, -1.3683e-03,2.9215e-06
4,ps,2,3.9161e+00, -4.6214e-03,9.5888e-06

Notes to the streak time scaling files:

***1**: Number of valid Channels

***2**: Streak camera name (as it appears in the time scaling setup)

***3**: Plugin camera name (as it appears in the time scaling setup)

***4**: Scaling information for one time range like:

2,ps,2,1.2818e+00, -3.7142e-04,6.8962e-07
| | | |
*5*6 *7 *8

***5**: Time range name (as it appears in the device status/control box)

***6**: Unit

***7**: Order of polynomial (n)

***8**: n Coefficients

Other notes:

The spelling of all names (Streak camera, plugin, time ranges) must be precise and Upper/ Lowercase must be correct

All entries must be separated by comma; the decimal delimiter must be a point.

Note: The Streak scaling setup has to be used when setting the time ranges for a Dual Time Base Extender, though the sweep direction is perpendicular to the streak sweep

Camera configuration files

Introduction > Installation > Using the "Select new camera Assistant "

Camera configuration files

The following camera configuration files are delivered with the HPD-TA. These files are installed and specified at installation time. If you use the Select new hardware wizard these files are selected automatically.

Configuration file..	...with frame grabber...	... for the cameras
DIGITAL.CNF	IC-PCI+AM DIG	All digital cameras like C4742 (ORCA) series and C4880 series
CCIR.CNF	IC-PCI+AM VS	For analog video cameras with CCIR standard
EIA.CNF	IC-PCI+AM VS	For analog video cameras with EIA standard
PCVSCCIR.CNF	PCVision	For analog video cameras with CCIR standard
PCVS_EIA640.CNF	PCVision	For analog video cameras with EIA standard

PCDig.txt	PCDig	All digital cameras
Ifc-hpk.txt	PCDig/PCCamLink	All digital cameras
Hamamatsu_DCAM.pcf	Phoenix grabber	All digital cameras
Hamamatsu_DCAM.ccf	X64 Xcelera, X64 Full, X64 iProLight	All digital cameras
P2V_CCIR.ccf	PC2-Vision	CCIR cameras
P2V_EIA.ccf	PC2-Vision	EIA cameras
The National Instruments frame grabber PCI 1422, PCI 1424, NI PCI 1426, and PCI 1428 do not require such file.		

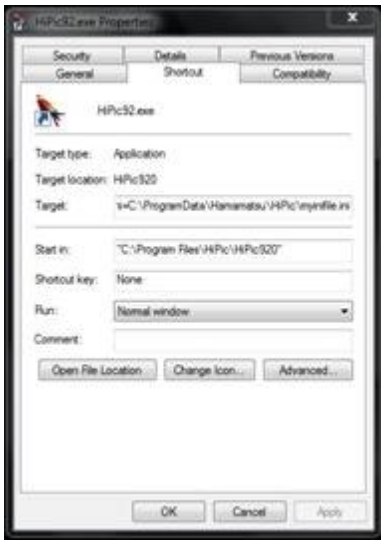
Setting a different file as *INI file.

Introduction > Installation

Setting a different file as *INI file.

The HPD-TA uses the file HiPic9.ini in the CommonAppData directory (under Windows 7 this is normally C:\ProgramData\Hamamatsu\HPDTA) as the default to store all parameters.

To specify a different file as the file which stores permanent parameters a command line argument can be used. The command line can be specified in the link to the program.



Instead of the default target:

C:\Program Files\HPDTA\HPDTA940\HPDTA94.exe

you can e.g use the following statement:

"C:\Program Files\HPDTA\HPDTA940\HPDTA94.exe" /ini=D:\myDirectory\myIniFile.ini

Basic operations

Basic operations

This topic describes how to perform basic operations of the program, how to get started and how to get familiar with it in short time.

Getting started

Basic operations

Getting started

This topic describes how to get started with the program.

Start the program

Basic operations > Getting started

Start the program

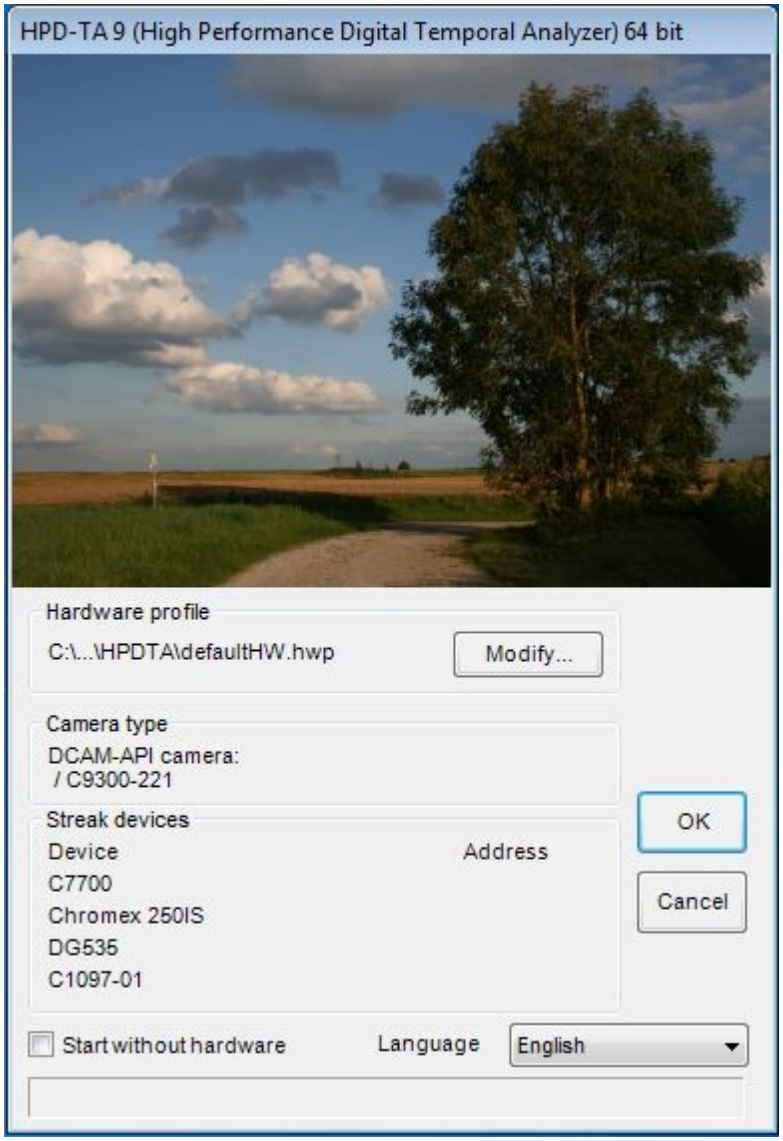
To start the program simply click to the icon  displayed on the desktop or select the appropriate command within the program tree:

Start

"Programs - HPDTA 9 - HPDTA 9.4" (for a 32 bit version) or "Programs - HPDTA 9 - HPDTA 9.4 - X64" (for a 64 bit version).

If you are familiar with the windows explorer and with starting programs by clicking on the executable files you can also locate the application directory and double-click to HPDTA94.exe.

The introduction screen will appear. You can select the hardware profile which contains settings about the connected streak devices, GP-IB board and counter/timer board, CCD camera settings and streak camera related calibration.



All these settings have been done during setup and/or installation by a Hamamatsu engineer and are kept permanently. We therefore assume that we do not need to make any modifications here and we can go on starting the program by hitting Enter or clicking to the OK pushbutton. If you like to cancel the starting process click to Cancel now.

Sometimes you want to start the program just for viewing and analyzing images. This can be done by selecting the option Start without hardware . This option is active only for the current session and will be reset the next time you start the program again.

Automatic detection of plugin or options change

Basic operations > Getting started > Start the program

Automatic detection of plugin or options change

The program checks during start whether the saved configuration is still active. If a plugin or options mismatch is detected the user is inquired whether he wants to continue with the correct setup. This, of course, is dependent on the hardware. This feature is only available for some devices like the C5680 and only if the device is connected by GPIB. If any configuration mismatch has been detected a warning message will be displayed.

To ensure configuration mismatch problems you should consider following:

External devices controlled by the HPD-TA should be powered on before you start the HPD-TA software. If you specify wrong devices (specifically GPIB-controlled ones), or wrong GPIB addresses in the Device Control Options, or if a device is not powered on at start-up or the

GPIB cable is missing etc, the HPD-TA software may without success try to communicate with the device. Depending on the circumstances, this can lead to a situation where the HPD-TA is almost not responsive to user interactions any more (seems to be hanging).

Unless you fix the problem at the device s side, exiting and restarting theHPD-TA software will not solve the problem, since device configuration is automatically saved and re-loaded between sessions. If you cannot resolve a problem, please contact the Hamamatsu support office.

Problems during startup

Basic operations > Getting started > Start the program

Problems during startup

If a problem happens during startup an error message will be issued. Please check all cable connections and the software settings like frame grabber and camera selection, COM port and baud rate setting in such case.

Getting started with streak camera operation

Basic operations > Getting started > Start the program

Getting started with streak camera operation

When you start operating your HPD-TA system we recommend to become familiar with the CCD camera **before** you operate the streak camera. You will operate your streak camera in a safer manner if you are familiar with the readout system, its features and commands. The **risk to damage** the **streak camera** is smaller in such case. To do so it is best to connect an ordinary objective lens in front of the CCD camera, focus a normal image on the camera and start the operation of the CCD camera as shown below. See also the Chapter on streak camera operation for further details.

Acquiring images from a camera

Basic operations > Getting started

Acquiring images from a camera

We assume that the CCD camera is already switched on.

If the camera is equipped with water cooling switch on the cooling water now. Some older cooled cameras have a vacuum pump to avoid condensation on chip. If so, please switch on this vacuum pump and open all necessary valves as has been explained during installation of the system. Most modern cameras however do not have such peripheral equipment as they are permanently sealed and there is nothing to do here.

Images can be acquired using the camera acquisition dialog. Even though the acquisition dialogs for different cameras look somehow different you will find the pushbuttons for Live mode and Acquire mode on every camera acquisition dialog. Most dialogs have also a Single image pushbutton which acquires an image with the parameters selected for live mode. Any image acquisition can only be started if the camera acquisition dialog is visible. This is to avoid acquisition with wrong or unexpected parameters. If the camera acquisition dialog is not visible, the first attempt to acquire an image will place the acquisition dialog on screen and only the next trial will start the acquisition.

Live mode/Single image

Basic operations > Getting started > Acquiring images from a camera

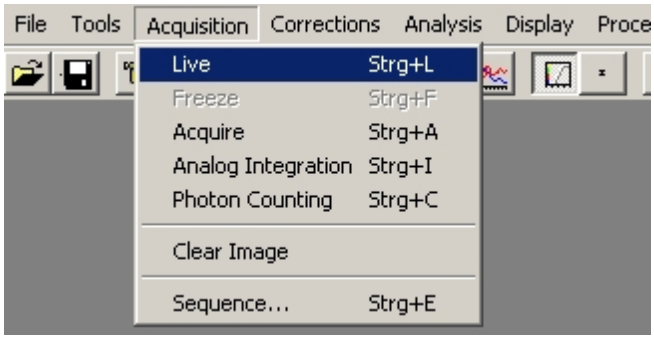
Live mode/Single image

Live mode is a mode to acquire and display images continuously. This mode is available for all cameras. In case of C4880 and ORCA II type cameras, the camera is switched to the fast readout mode. If a user wants to get only one single image with the currently selected parameters most camera acquisition dialogs have a single image function. Some cameras have a control to select the scan speed on every Acquisition tab so that there is the

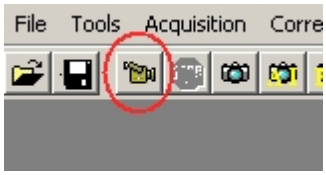
possibility to assign an individual scan speed to each acquisition mode.

To start Live mode proceed as follows:

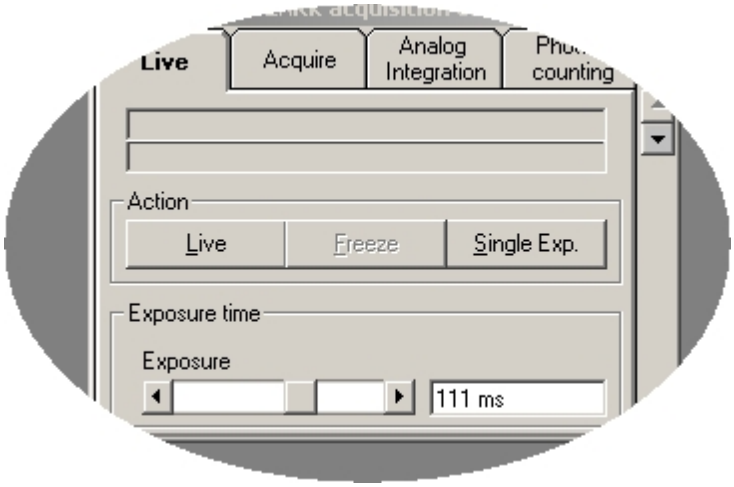
1.) Show the acquisition dialog
Select Live from the Acquisition menu



- or
Click to the Live Toolbar button



The acquisition dialog will appear on screen



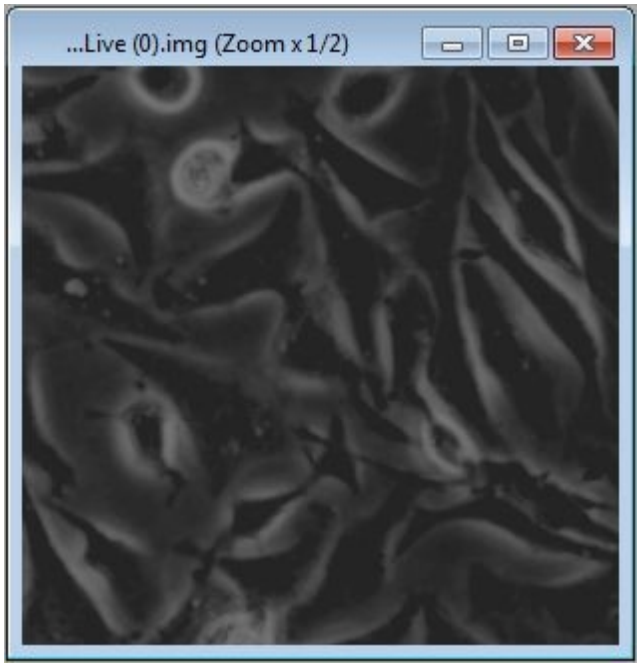
2.) Start Live mode
(If the acquisition dialog was already visible Live mode will start with step 1.))

To Start the LIVE mode

Click to the Live pushbutton on the Acquisition dialog
- or
Click to the Live Toolbar button
- or

Select Live from the Acquisition menu

The live image will appear on screen and show a continuously updated image.



To stop LIVE mode

Click to the Freeze pushbutton on the Acquisition dialog

- or

Click to the Freeze Toolbar button

- or

Select Freeze from the Acquisition menu

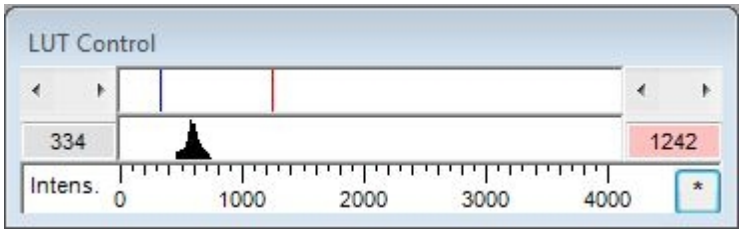
To execute single exposure Click to Single Exposure on the acquisition dialog.

LUT

Basic operations > Getting started

LUT

If you acquire images you will find that the images are frequently displayed with too low or too strong contrast. If you acquire images under low light level conditions the display may be too dark. Use the LUT tool to adapt the image display to the desired contrast.



Lut tool.

The LUT tool has two cursors (two colored lines, one is blue and one is red) which defines the intensity limits of the currently displayed intensity range. To find the correct range the easiest way is to click on the small asterisk * on the right bottom side of the LUT tool. A

similar pushbutton can be find on the toolbar: 

Please see also the chapter LUT, LUT Parameters and the Appendix LUT in this document.

Change the display size of the image (zooming)

Basic operations > Getting started

Change the display size of the image (zooming)

Important note for users of previous versions: While older versions (before version 8) of this programs use the right mouse button to zoom out, this version uses the left mouse button + Shift key to zoom out.

Once an image is acquired it will be displayed on screen within a window. Depending on the number of pixels in the image and the resolution of the computers screen the image may be either too small or too large to be seen correctly. Therefore the image can be zoomed with a factor larger than one (if the image is too small) or a factor smaller than one (if the image is too large).

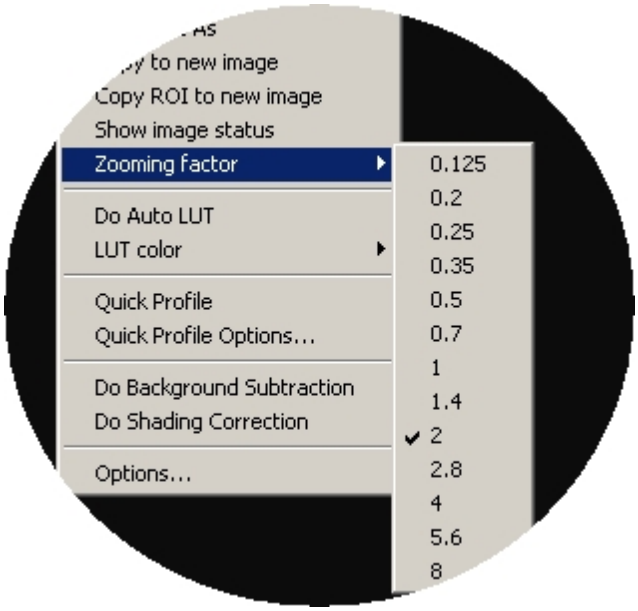
To change the zooming factor of an image

1.) Select zooming on the toolbar

2.) Click on the image with the left mouse button to enlarge the image and click with the left mouse while holding down the Shift key to reduce the image.

- or -

Select the zooming factor with the context sensitive menu by clicking on the image with the right mouse button.



See also the chapter Image Display Windows in the document.

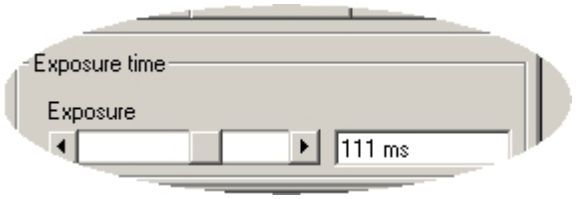
Setting camera parameters

Basic operations > Getting started

Setting camera parameters

If the image you get by this procedure is not satisfactory there may be several reasons. In case of a cooled camera you may need to switch on the peltier cooler now. It may be

necessary to focus or adjust the optics and it may also be necessary to adjust the exposure time here. The most important camera parameter is the exposure time. With very few exceptions all CCD cameras have an exposure time control on the camera acquisition dialog.



In general it is a slidebar where you can increase the exposure time by clicking on the right arrow and decrease it by clicking on the left arrow. Normally also an edit box allows to enter the exposure time directly. In this case the exposure time should be activated by pressing the Tab key.

When entering the exposure time by the edit box and the inputted exposure time is not an element of the list there are two possible behaviors depending on the camera type. Some cameras simply select the list entry which is closest to the selected exposure time. Other cameras just set the entered exposure time even if it is not a member of the list. In this case there is no relationship between the slider setting and the real exposure time.

If the image you get is too faint increase the exposure time, if it is too bright decrease the intensity. If portions of the image became red (or white in the case the color setting is rainbow) the CCD camera is saturated, which means the exposure time is too high. If the intensity is still too high you may need to decrease the light level of your sample or close the iris of your optics.

See also the chapter CCD camera control and CCD camera in the document.

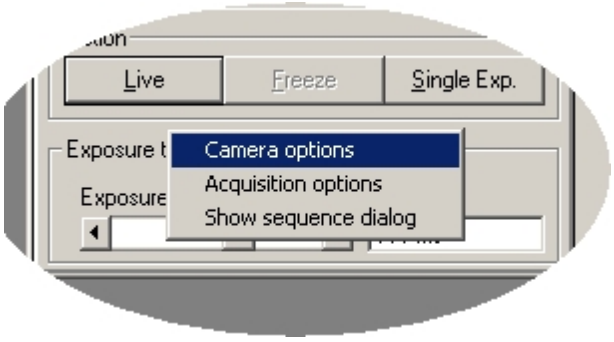
Acquisition/Options dialog

Basic operations > Getting started

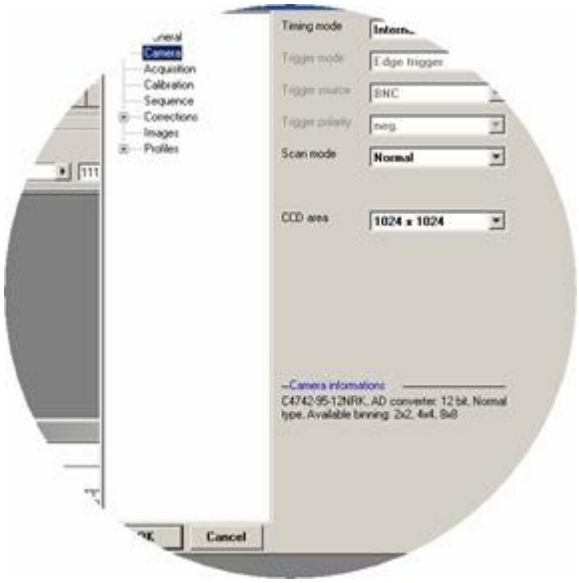
Acquisition/Options dialog

The exposure time however is only one parameter of the CCD camera which can be set by the software. Depending on the type of CCD camera many other parameters can be set now. It is a good idea to consult the CCD cameras hardware or operations manual and find out which features and parameters are provided by the model. All these features can by controlled from the software by using two main dialogs: the camera acquisition dialog and the options dialog. The parameters are separated in a way that parameters which are normally used and changed very often can be found in the camera acquisition dialog. To avoid that the camera acquisition dialog is burdened with many - often unchanged parameters, these less needed parameters are collected in the camera options dialog.

The camera acquisition dialog is always placed on screen when you execute an acquisition command. The simplest way to show the camera options dialog is to right click on the camera acquisition dialog and select Camera options.



The camera options dialog will then appear on screen.



Once the camera options dialog is displayed you can make all modifications of camera parameters. When clicking OK these modifications will me applied, when clicking to Cancel the old settings are restored. See also the chapter List of all camera dialogs for details.

Saving and loading images

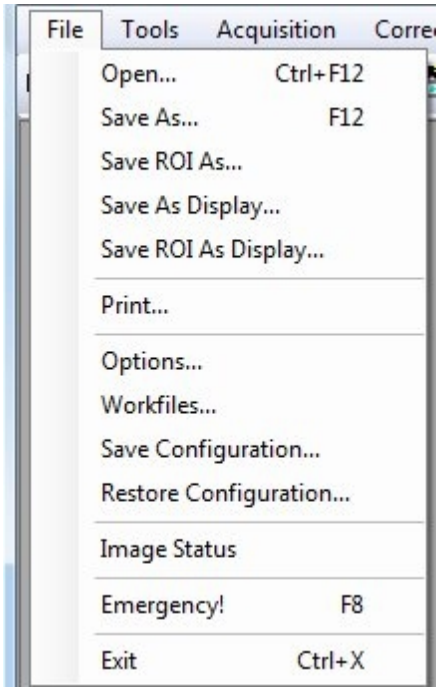
Basic operations > Getting started

Saving and loading images

Once you have acquired useful image data you may want to save them to disk.

To save an image to disk proceed as follows:

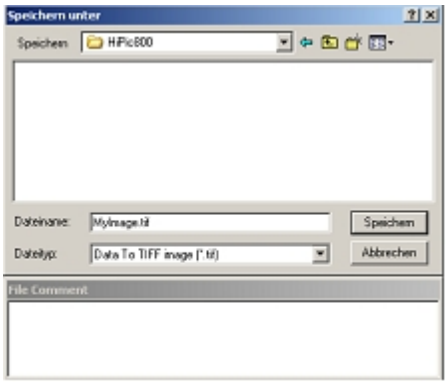
Select the File Save As menu command.



- or -

Click to the Save As toolbar button

A dialog appears to allow specifying file name directory and filing type of the file. Additionally you can type a comment which is then saved into the file header. There are several file types which you can use. At start we recommend to use either ITEX (*.img) or Data2Tiff (*.tif) as these file types allows to store the full dynamic range in an image.



Click to Save if you want to save the image now or Cancel if you want to cancel the save operation.

See also the chapter Saving and loading images in this document.

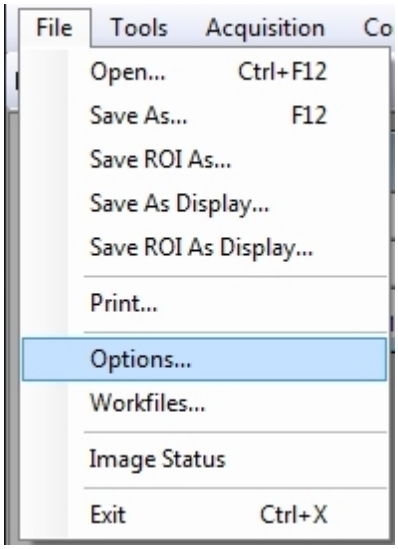
Options

Basic operations > Getting started

Options

The exact behavior of the program is specified in different options dialogs. To access the options either

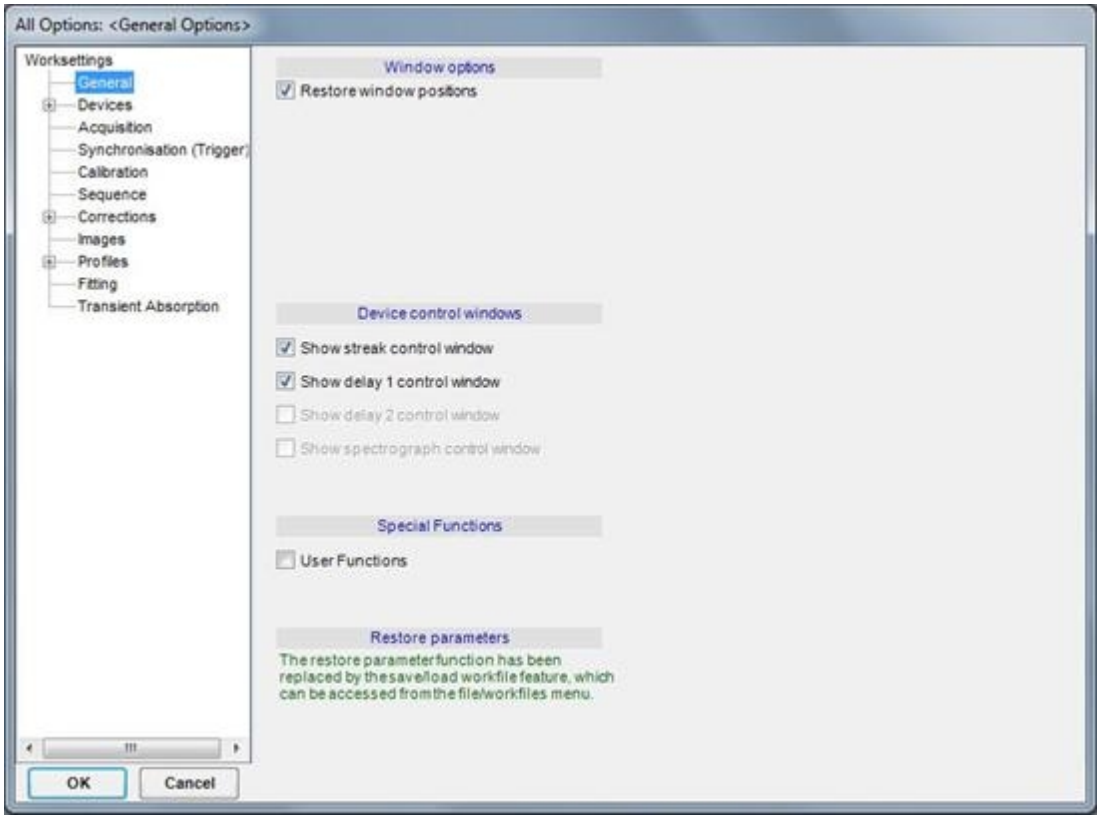
Click the File options menu



- or -

Click with the right mouse button on the dialog in which circumstance you want to specify options.

The options dialog will appear



The options dialog contains all options of all different areas of the software. To navigate between different dialogs the tree control on the left side can be used. The individual options dialog will then appear on the right side. The options dialog is a modal dialog which means you have to close it before you can continue your work. Clicking to OK closes the dialog and applies all changes to the software. Clicking to Cancel closes the dialog and restores the settings of the software which have been active before the Options dialog has been called.

See also the chapter Options in this document.

Quick profile

Basic operations > Getting started

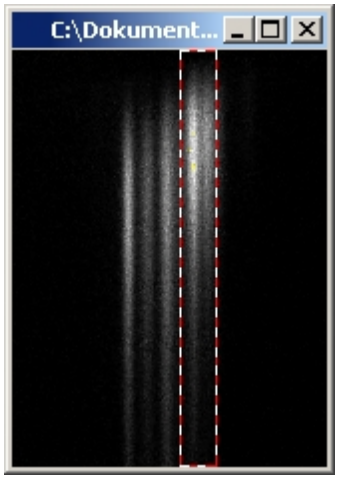
Quick profile

During image acquisition one or more profiles could be shown on the same window where the image data is displayed. Because it is immediately updated when a new image appears it is also called quick profile.

To display a quick profile:

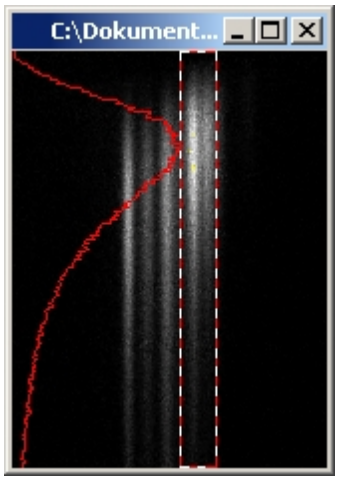
1.) Select the type of quick profile you want to get on the tool bar. We assume that we want to display a vertical profile over the full size of the image.

2.) Click to the image with the left mouse button and move the mouse while holding down the left mouse button. A new full size vertical ROI will be created.



3.) Click to the PRF button on the toolbar.

The quickprofile appears.



Clicking to PRF button on the toolbar again hides the quickprofile.

To move the ROI click on the ROI with the left mouse button and move the mouse.

To delete the ROI make sure that the image dialog is the active window and press the Del key on your keyboard. See also the chapter Image Display and LUT - Quick profile Selecting Measurement Parameters Quickprofilefor details.

Basic steps when operating a streak camera

Basic operations > Getting started

Basic steps when operating a streak camera

The streak camera is a very sensitive tool to measure ultra fast light emission phenomena. The streak camera can be used for a wide input light power range, but due to the very high sensitivity of the streak camera the streak tube can be damaged very easily when the input light power is too high.

	**Warning! Danger of tube damage. Always check input light power before opening the shutter.**

Because the streak camera can be used in many totally different applications we can t give you a precise value for the maximum input light power but we can outline general rules for safe operation.

Note: This document is mainly a description of the software and cannot describe all possible hardware configurations.

This topic therefore cannot cover all possible configurations and may not be able to account for your specific hardware. It does not try to replace the training which normally is done during a streak cameras installation.

Please read your Streak camera manual for any further detailed information.
If you re not familiar with your Streak camera please contact Hamamatsu for support or training.

Please follow the following steps to get familiar with the operation of a streak camera.

1. Step: Before switching on the streak camera please check that the input slit is closed! Afterwards switch on the streak camera including all related hardware and finally start the HPD-TA software.

2. Step: Before applying any light to the photocathode set the streak camera to Focus Mode, close the shutter, set the MCP gain to 0 and finally check the closed slit once again.

3. Step: View the image of the CCD-camera in Live mode with a typical exposure time of around 200ms. Press the Auto LUT button for a better visualization of the CCD camera image.

4. Step: Open the shutter (in Focus Mode and Gain 0 or 1).

5. Step: Slowly open the slit to about 10µm (carefully check light intensity in the Live image during opening the slit),
- if the light level in the image is very high (overflow in the CCD camera image) close the slit immediately and reduce the input light power* with an additional neutral density filter or similar
- if the light level is very low (weak signal) slowly increase the input light power.

*Remark: for this first function test it s not recommended to use the laser light. It s much easier and in parallel more save to use room light instead.

6. Step: Check the width (FWHM) of the Focus line by selecting a vertical ROI and compare the result with the theoretical value which is described in the Test report sheet (Static Spread Function) . Improving the Focus adjustment of the input (output) optics might be necessary to reach minimum FWHM.

7. Step: Close the slit and the shutter and adjust the laser light towards the streak input optics. Please attenuate the laser light to a very moderate level! Afterwards repeat Steps 4-6 once again.

8. Step: switch to operate mode and search the (laser) signal by changing the trigger delay timing.

General notes:

Before changing (adjusting) the light path, protect the streak camera by closing slit and shutter and set MCP to 0.

Danger of streak tube damage due to too high input light power.

Switching from deflection mode (Operate Mode or dual time base extender On) to non-deflection mode (Focus Mode or dual time base extender Off) can damaged the MCP. Even with the safety protection (shutter closed, MCP gain 0) of the streak camera a degradation of the MCP can be the result of a short operation above saturation level. The safety function of the streak camera (shutter closed, MCP gain 0) has a delay which can be large enough so

that the MCP degradation gets large after some years.

Before switching from deflection mode to non-deflection mode set the MCP gain to 0 and close shutter and slit.

Switching off

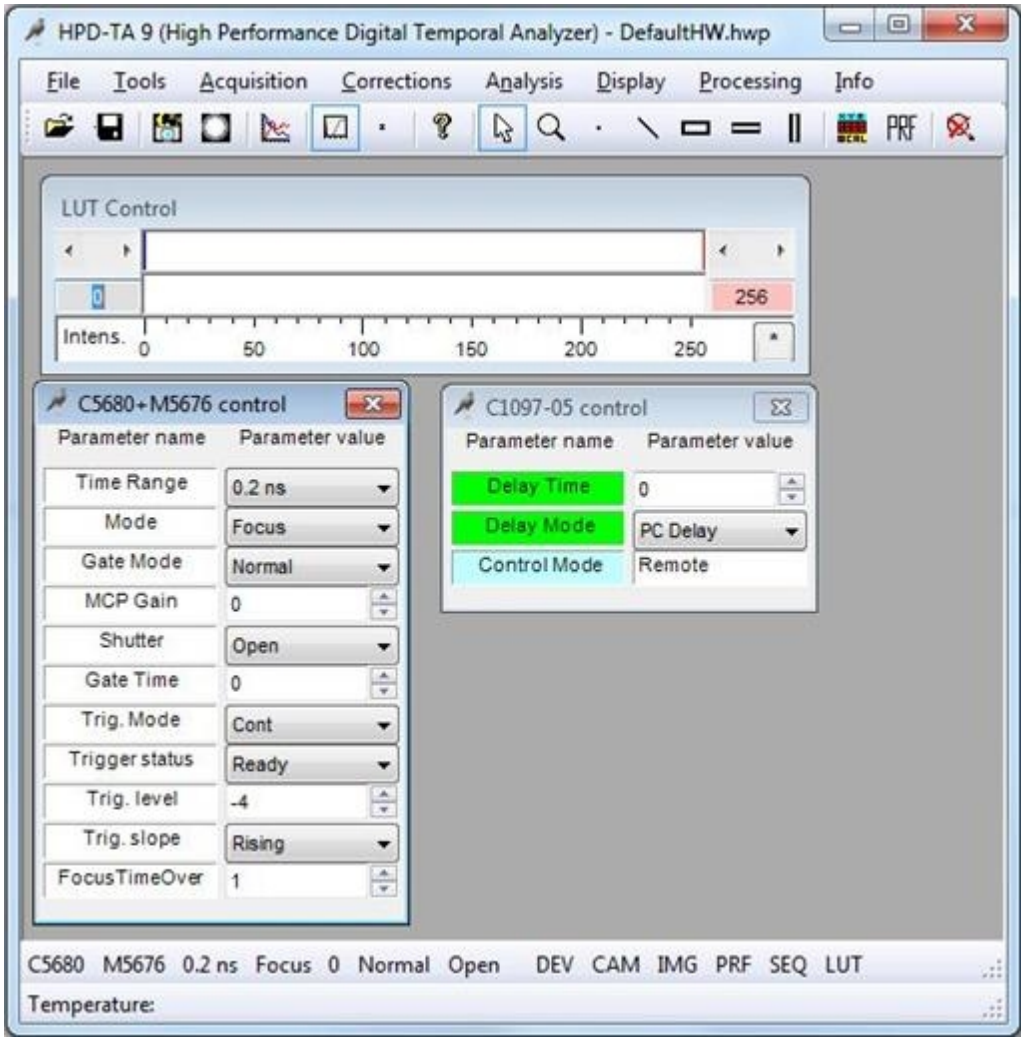
Set the MCP gain to 0, close the shutter and slit and place the protection cover in front of the streak input.

The elements of the user I/F

Basic operations

The elements of the user I/F

This chapter explains the basic elements of the user interface and its general functionality. Every function is explained in more detail in further chapters if necessary. The following screenshot shows the main window after program start.



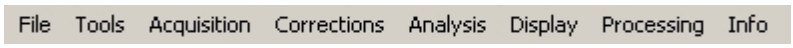
The menu

Basic operations > The elements of the user I/F

The menu

The menu of the program allows easy access to the most important commands. It consists of

the main menu and a submenu for every entry in the main menu.



The Toolbar

Basic operations > The elements of the user I/F

The Toolbar

The toolbar is a selection of pushbuttons which provides easy access to many important commands.

The status bar

Basic operations > The elements of the user I/F

The status bar

On the bottom part of the program window status information is displayed. The content depends on the actual conditions. E.g. during LIVE mode the actual frame rate will be displayed

While the mouse cursor is inside of an image window, the co-ordinates and the intensity value at the current mouse position are displayed.

Child windows and System modal windows

Basic operations > The elements of the user I/F

Child windows and System modal windows

Some windows used in the software are placed in the client area of the main window and cannot be larger than the main window. These windows are called child windows. Most of the windows in this software are child windows like the acquisition dialog or the image display windows.

Other windows are used to make special setting and it is useful that the process of setting is finished when the user wants to continue his routine work. These windows are so called modal (or system-modal) windows. Other windows of the software e.g. the main window cannot be accessed unless the modal window has been closed. Normally these modal windows have two push button on the bottom:

- A pushbutton OK to apply the settings and close the dialog
- A pushbutton Cancel to restore the previous settings and close the dialog.

Options, Acquisition and Tool dialog windows

Basic operations > The elements of the user I/F

Options, Acquisition and Tool dialog windows

There are three different types of dialogs within this software:

- Option dialogs
- Acquisition dialogs
- Tool dialogs

Option dialogs

Option dialogs allow to set values of certain parameters which specify the behavior of the software. These parameters are static settings, which are normally restored from one session to the next. Option dialogs have to be closed after the settings are done to continue with the work.

Acquisition dialogs

Acquisition dialogs are dedicated to create image and related data. They are placed in the client area of the main window and can coexist with other windows especially image display windows.

Tool dialogs

Tool dialogs are dedicated to create other type of data like calibration data or defect pixel data which are further used for certain system settings. They are also placed in the client area of the main window and can coexist with other windows especially image display windows. These dialogs are normally not used during routine work

Arranging windows/Activating dedicated windows

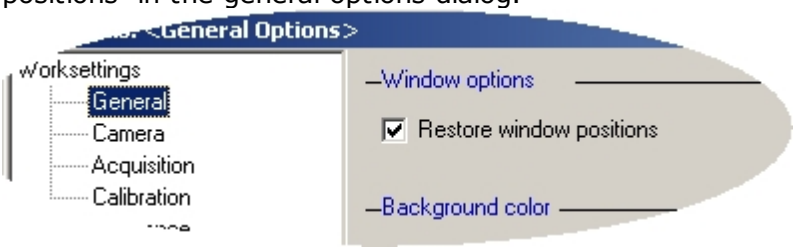
Basic operations > The elements of the user I/F

Arranging windows/Activating dedicated windows

To perform several tasks normally several dialogs have to be on the screen. This can sooner or later lead to an untidy and somehow messy screen. Even though the user still may need several dialogs at once there are two measures to handle this problem

Restore window positions

One can arrange the windows freely at the screen and there is an option to restore a window at the same location where it has been previously. There is an option Restore window positions in the general options dialog.



If this option is checked the position of every window will be remembered and the window placed at the same location where it has been. So it is easy to arrange the dialogs in a fixed way where they can be find easily.

Find windows which are hidden under other windows

On the status bar there are some pushbuttons which makes it very easy to get the desired windows on top which are mostly used:

These pushbuttons can be used to show the dialogs if they are already on screen but hidden under another dialog (if they are not on screen nothing will happen).

DEV Show all status/control window of the streak devices

CAM Shows the camera acquisition dialog

IMG Shows all image display windows

PRF Shows all dialogs related to profile

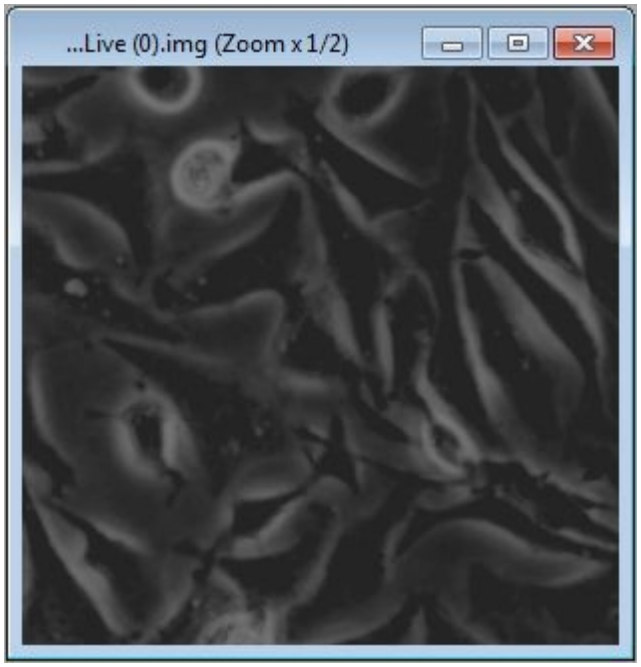
SEQ Shows the sequence dialog

LUT Shows the LUT tool

Image display windows

Image display windows

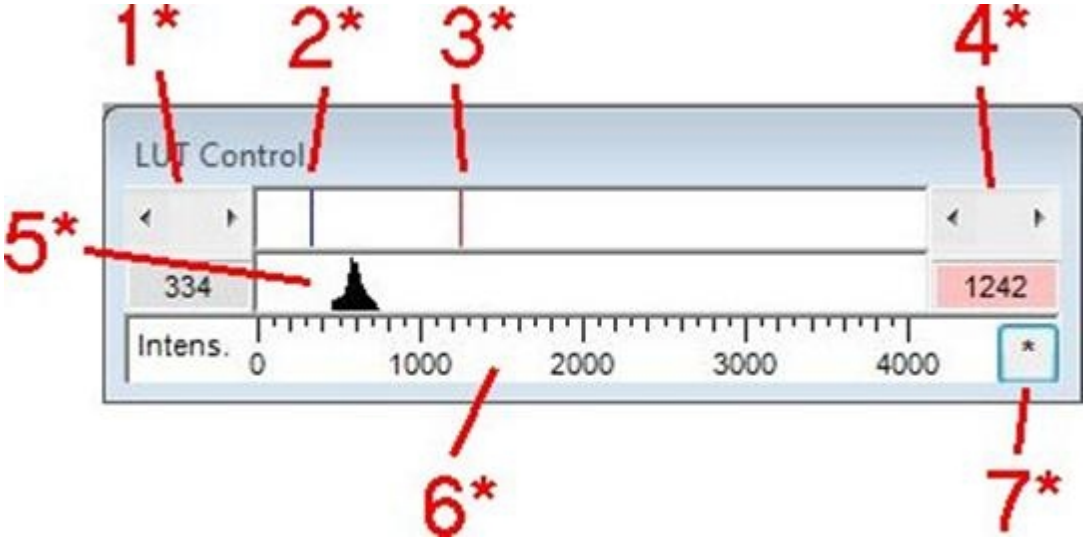
Image data is displayed on separate image display windows. A maximum of 20 image display windows can be displayed at once. Once an image window is created an entry is made in the menu windows. If more than one window is displayed at a time one of these is always the current (or selected) one. Every function which refers to image data is always processed on the current window. As an example, if you want to save one specific image to file click on the image windows caption (or to another part of the image). This makes the image the current one. Then click to the Save As function to save the current image.



LUT

LUT

The LUT tool is used to control the image display by manipulating its brightness and contrast.



1*: Slide bar to change the lower limit

2*: Lower Limit

3*: Upper Limit

4*: Slide bar to change the upper limit

5*: Histogram

6*: Input intensity scale

7*: Pushbutton for Auto LUT

The LUT Tool

If you acquire images you will find that the images are frequently displayed with too low or too strong contrast. If you acquire images under low light level conditions the display may be too dark. Use the LUT tool to adapt the image display to the desired contrast.

ROIs

Basic operations > The elements of the user I/F

ROIs

There are many image processing functions which refer to image data like saving the data to file or extracting profile data. Most of these functions however can not only be applied to the full image but also to a subset of the image data. For this purpose Regions of Interest (shortly called ROI) can be used. There are different types of ROIs which can be used for different purposes. The types of ROIs are:

·	Point ROI
╲	Arbitrary line ROI (this includes line ROIs with width > 1)
▭	Rectangle ROI
═	Rectangle ROI with full size in horizontal direction
‖	Rectangle ROI with full size in vertical direction

To create a ROI first of all select the ROI type on the toolbar:

Then draw the ROI with clicking to the starting point with the left mouse button, then draw the mouse to the end point of the ROI and release it. Afterwards you can move the ROI by clicking to it with the left mouse button and moving the mouse to the desired position. You

can select up to 10 different ROIs on one image. A more detailed description of how to create, select, delete and use ROIs can be found in the chapter ROIs

Context sensitive menus

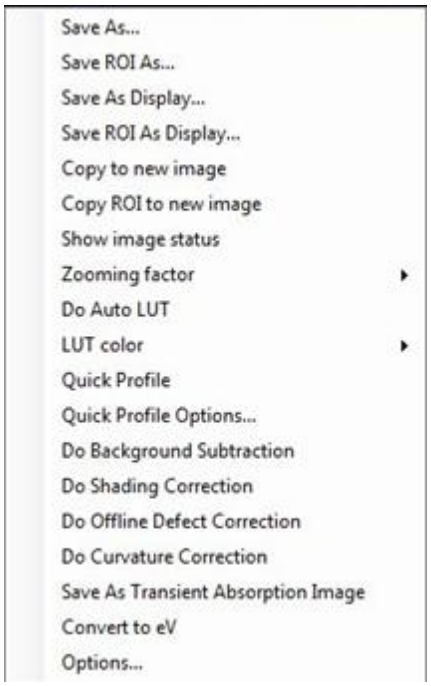
Basic operations > The elements of the user I/F

Context sensitive menus

From any given dialog the user can reach the most related dialogs and commands by just right click to the dialog. A context sensitive menu will appear and show commands which may be important in this circumstance. We want to look at two different examples to show this feature:

If you click with the right mouse button on the sequence dialog you will get the following menu:

If you click with the right mouse button on the image display dialog you will get the following menu:

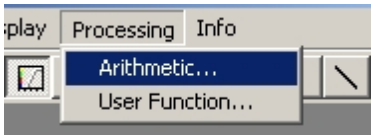


Using commands from the menu

Basic operations

Using commands from the menu

The menu is a way to easily access the most important commands or dialogs. It consists of the main menu which can be seen on the top of the main window and several submenus. To select a submenu click to the main menu entry and select the submenu entry. For example of you want to select the arithmetic menu first click to processing main menu, then select Arithmetic and click to it.



The main menu

Basic operations > Using commands from the menu

The main menu

The menu of the program consists of the following main entries:

Command	Description
File	Contains a set of commands related to image files and other general properties
Tools	Contains commands to create special data
Acquisition	Contains commands to acquire image data
Corrections	Contains commands to perform different corrections on images
Analysis	Contains commands to analyze image data
Display	Contains commands to control and optimize image display
Processing	Contains image processing commands
Window	Contains commands to select and close image display windows
Info	Contains commands to get information about the program and a tool to communicate with the camera directly

File Menu

Basic operations > Using commands from the menu

File Menu

The file menu contains the following entries

Open	Loads an image or image sequence in IMG, TIFF or other formats.
Save As	Saves the current image or image sequence in IMG, TIFF or other formats.
Save ROI As	Saves the specified ROI of the current image or image sequence in IMG, TIFF or other formats.
Save As Display	Saves the current image or image sequence in Display to TIFF format.
Save ROI As Display	Saves the specified ROI of the current image or image sequence in Display to TIFF format.
Print	Print the current image
Options	Shows a dialog which displays and allows to modify all available options
Workfiles	Allows to save and load all current options and other settings to a file

Save Configuration	Allows to save the complete configuration including INI file, hardware configuration and scaling files
Restore Configuration	Allows to restore the complete configuration including INI file, hardware configuration and scaling files
Image status	Shows the current image status
Emergency!	Closes the streak shutter, sets the MCP gain to zero and closes the spectrograph slit (if available and controllable)
Exit	Shuts down the program

Tools menu

Basic operations > Using commands from the menu

Tools menu

The tools menu contains the following entries

Calibration files	Shows a dialog which allows to create, modify and save calibration files
Curvature correction	Shows a dialog which Allows to setup data for the curvature correction
Defect pixels	Shows a dialog which allows to analyze images containing defect pixel
Photon Correlation Converter	Shows a dialog which allows to convert DPC files to DPT format while calculating the trace number for photon correlation measurement.

The acquisition menu

Basic operations > Using commands from the menu

The acquisition menu

The acquisition menu contains the following entries

Live	If the Acquisition dialogue is not opened, it will be opened as you click this button for the first time. If you click it while the Live mode dialogue is open, image acquisition in **Live** mode will be started. The acquisition parameters as shown in the Live mode dialogue are used.
Freeze	**Live** mode stops. The last image will remain in memory..
Acquire	If the Acquisition dialogue is not opened, it will be opened as you click this button for the first time. If you click it while the Acquire mode dialogue is open, an image acquisition in **Acquire** mode will be executed. The acquisition parameters as shown in the Acquisition mode dialogue are used
Analog Integration	If the Acquisition mode dialogue is not opened, it will be opened as you click this button for the first time. If you click it while the Analog integration mode dialogue is open, an image acquisition in **Analog integration** mode will be executed. The acquisition parameters as shown in the Analog integration mode dialogue are used.
Photon Counting	If the Acquisition mode dialogue is not opened, it will be

	opened as you click this button for the first time. If you click it while the Photon counting mode dialogue is open, an image acquisition in **Photon Counting** mode will be executed. The acquisition parameters as shown in the Photon counting mode dialogue are used. See.
Clear Image	The **Clear Image** command clears the image data
Sequence	This command shows the sequence dialog which allows the acquisition of a series of images with storage on computer memory (RAM) or hard disk. This dialog includes also a sequence replay function.
Transient absorption	The transient absorption command shows the transient absorption measurement window. Note: The transient absorption measurement system is an option, which has to be purchased separately. The transient absorption command is only available if the software protection contains a key for this for it.

The Corrections menu

Basic operations > Using commands from the menu

The Corrections menu

The acquisition menu contains the following entries

Background subtraction	This function allows subtracting a background image. This can be used to subtract the camera dark current
Shading correction	This functions allows to correct the shading of images
Curvature correction	The Curvature Correction command corrects geometric distortion of the currently active image.

The analysis menu

Basic operations > Using commands from the menu

The analysis menu

The analysis menu contains the following entries

Profile	This function allows to display and analyze profiles
Histogram	This function allows analyzing the intensity distribution (histogram) of an image.
3D-Data	This function allows displaying image data in a numerical (table) form. Please note that from version 9.4 there is a so called Bird view mode which can be use for a 3-D display
Fitting	This function allows to fit measurement data to analytical functions

The display menu

Basic operations > Using commands from the menu

The display menu

The display menu contains the following entry:

LUT	This function shows the LUT parameters dialog on screen. The LUT parameters dialog allows to change parameters like to color of the display.

The Processing menu

Basic operations > Using commands from the menu

The Processing menu

The Processing menu contains the following entries:

Arithmetic	This function allows to perform arithmetic operations on image data
User function	This function allows to execute user function commands
Superimpose	This function allows to superimpose the image data of two images

The Window menu

Basic operations > Using commands from the menu

The Window menu

The Window menu displays all the currently available image windows. It also contains the Close All command which allows closing all image windows with one command.

The Info menu

Basic operations > Using commands from the menu

The Info menu

The Info menu contains the following entry:

Help	This function calls the help dialog
Help on Transient Absorption	This function calls the help dialog for the Transient Absorption measurement function (optional, special license required).
Help on TA-Fit	This function calls the help dialog for the fitting function (optional, special license required).
RS232	This function allows to send and receive commands from the connected camera (if it is connected by RS232)
About	This function displays the About dialog which tells the user details about the version of the program

Using commands from the toolbar

Basic operations

Using commands from the toolbar

The toolbar similar to the menu allows to access the most important commands in a very easy way. To execute a command by the toolbar simply click to the icon on the toolbar.

Most of these icons can be understood without an explanation.

The following is an explanation of all toolbar icons used on the toolbar:

	Open	Opens an image file
	Save As	Saves the currently selected image to file
	Live	Starts live mode (or shows the camera acquisition if not on screen)
	Freeze	Freezes live mode
	Acquire	Acquires an image in Acquire mode
	Analog Integration	Acquires an image in Analog Integration mode
	Photon Counting	Acquires an image in Photon Counting mode
	Background Subtraction	Applies Background Subtraction to the currently selected image
	Shading Correction	Applies Shading Correction to the currently selected image
	Profile	Shows or hides the profile dialog
	LUT dialog	Shows or hides the LUT dialog
	About	Shows the About dialog
	Pointer	Selects Pointer mode. This allows selecting and modifying ROIs.
	Zoom	Selects zooming mode. This allows to change the zooming factor of the image
	Create Point ROI	Selects Point ROI mode. This allows creating a Point ROI.
	Create Line ROI	Selects Line ROI mode. This allows creating a line ROI. This ROI can have an arbitrary direction. It can also have a width larger than one.
	Create general rectangle ROI	Selects Rectangle ROI mode. This allows creating a rectangle ROI of any size.
	Create horizontal rectangle ROI (full image width)	Selects horizontal rectangle ROI mode. This allows creating a rectangle ROI with full horizontal size.
	Create vertical rectangle ROI (full image height)	Selects vertical rectangle ROI mode. This allows creating a rectangle ROI with full vertical size.
	ROI Interface	Shows or hides the ROI Interface dialog
	Quick profile	Shows or hides the quick profile
	Unzoom current	Sets the current image to the default zooming factor

CCD Camera control

Basic operations

CCD Camera control

Hamamatsu CCD cameras and other imaging devices are sophisticated state of the art technical devices which in general have many different operation modes. To get familiar with these operating modes you should consult your operations manual of the CCD camera. Depending on your purchase contract there may also be an installation and introduction done by a Hamamatsu engineer on your site. Also this introduction is a good opportunity to get familiar with the features and operations modes of the camera. Most of the features of your CCD camera can be controlled by software (There may be some features which can only be controlled by hardware devices like potentiometers or the like. In this case you cannot control the features by software).

Acquisition/Options Dialog

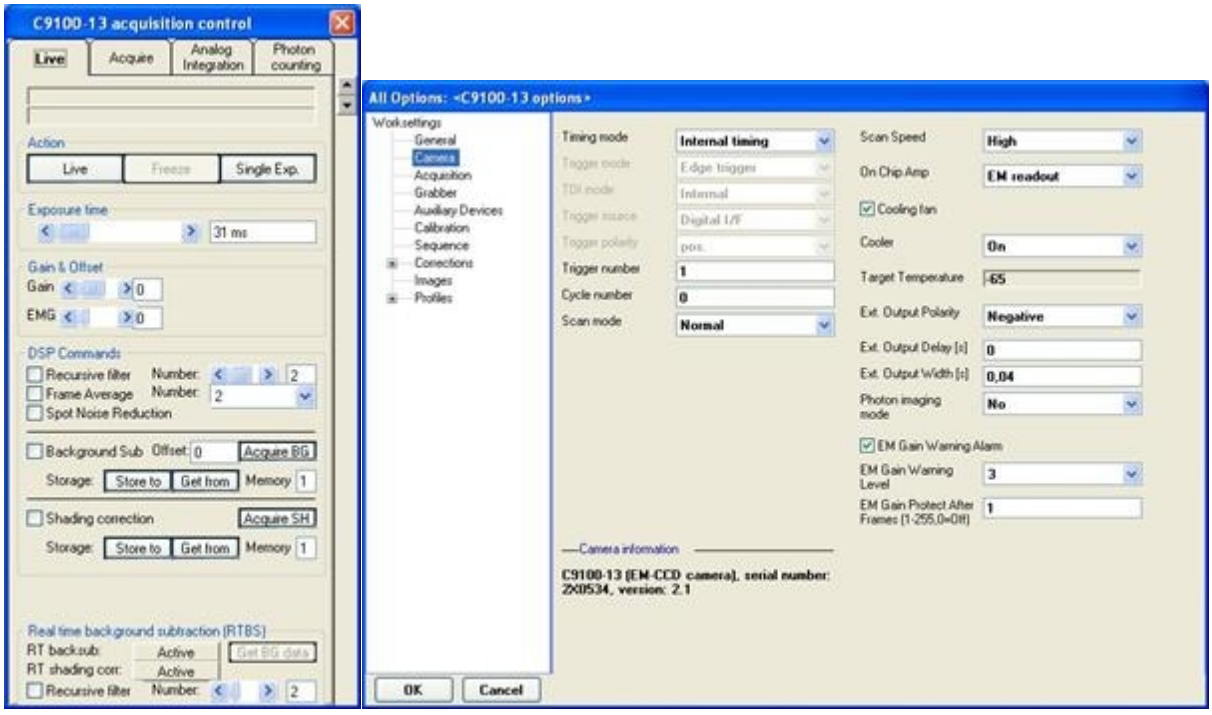
Basic operations > CCD Camera control

Acquisition/Options Dialog

All features can be controlled by two dialogs:

The camera acquisition dialog and the camera options dialog. In very few cases there is a third dialog which controls the subarray feature of the camera. The camera acquisition dialog is a dialog which is placed on the client area of the main window and can stay there without a limitation. The camera options dialog is showed as a modal dialog. This means that the options dialog has to be closed before the user can continue his routine work.

As the features of different cameras are different also the camera control dialogs look different. As an example we show the camera acquisition dialog and camera options dialog of the ImagEM (C9100-13).



Often/Seldom used parameters

Basic operations > CCD Camera control > Acquisition/Options Dialog

Often/Seldom used parameters

The parameters to control a camera are distributed in a way so that the seldom used parameters are placed in the camera options dialog, whereas parameters which are likely that they are used more often are placed in the camera acquisition dialog.

Camera acquisition dialog: Smaller/larger

Camera acquisition dialog: Smaller/larger

The camera acquisition dialog can be made smaller or larger with two small arrows on the upper right side. Depending on the number of acquisition parameters the user wants to see he can make the dialog smaller or larger

Small camera dialog

Large camera dialog

Acquisition modes

Acquisition modes

Different acquisition modes can be used to acquire image data from a camera. The parameters a stored together with the acquisition mode and reactivated when the user reselects the acquisition mode.

Camera/Acquisition parameters

Camera/Acquisition parameters

There are parameters which directly modifies settings inside the camera. We call these parameters camera parameters.

There are parameters which do not change any setting inside of the camera but still influences the result of the acquisition, like the exposure number of an Analog Integration. We call these parameters acquisition parameters.

Value range of parameters

Basic operations > CCD Camera control > Acquisition/Options Dialog

Value range of parameters

Depending and the camera and the setting of other parameters the value range of certain parameters can vary. For example if the Binning mode is set to 1 x 1 for an Orca camera, subarray settings for X and Y can range from 8 to 1024. If the same Orca camera is operated in 2 x 2 binning the subarray settings can only range from 8 to 512. Many parameters are depending on each other. If possible parameters are arranged in a way the parameters from the options dialog influence parameters in the acquisition dialog but not vice versa.

List of camera parameters

Basic operations > CCD Camera control

List of camera parameters

The following is a complete list of all camera parameters which appears in all supported cameras, its range of values and an explanation of the meaning of the parameter.

The list is in alphabetic order so you can easily find any supported parameter.

The naming of the camera parameters is closely related to the naming of the respective parameters described in the camera manual. Therefore it is highly recommended to check the operations modes and parameters in the camera manual to understand the meaning of these parameters.

Sometimes the same features have a different naming in different camera modules. In such cases all the different versions are listed and separated by a horizontal line.

In the case the camera is supported through a DCAM module the naming of parameters can be differ somewhat from the description here. In rare cases also different parameters can appear in this case. This list may still useful to find out the meaning of the parameters.

Parameter	Refers to	Range	Description
Actual temperature		Real number normally with a precision of 0.1 degree.	Displays the actual CCD temperature
Alternate trigger (Uses Control2 output)	Generic-Cam	True / False	Use the alternate trigger as output which is Control 2. this parameter has only a meaning for the NI PCI 1422 and PCI 1424 frame grabber
Baud	Generic-Cam	List of values	Specifies the baud rate for the serial communication with the camera
BG sub - Background Sub		On / Off	Starts or stops a background subtraction function inside the camera
Binning		1x1 / 2x2 / 4x4 / 8x8 / 16x16 - Different factors	The charges of neighboring pixels are accumulated to yield one new pixel. Binning increases the sensitivity and decreases the resolution / number of pixels. In

		in two directions	special case the binning is performed after the readout in a digital processing inside the camera
Bits per Pixel		8 / 12	Specifies the number of bit outputted from the camera
Camera type		Text	Describes the camera type
Check before correction data acquisition: Background data acquisition: Background level in any pixel	Line scan camera	Integer number	Prior to background data acquisition it is check whether the intensity does not exceed this level
Check before correction data acquisition: Number of times to check	Line scan camera	Integer number	Specifies how often an intensity check is done before the correction data is acquired
Check before correction data acquisition: Sensitivity data acquisition: Minimum level in any pixel	Line scan camera	Integer number	Prior to sensitivity data acquisition it is check whether the intensity is not lower than this level
Check before correction data acquisition: Sensitivity data acquisition: Fluctuation in % (+/-)	Line scan camera	Integer number	Prior to sensitivity data acquisition it is check whether the intensity does not vary more than the specified percentage
Chip - Chip type		Text	Displays the Type of CCD chip
Contrast enhancement		Off / Potentiometer / Computer control	Specifies whether and how an analog contrast enhancement is active and whether the parameters can be specified by potentiometers or by computer control.
Cooler - Cooler on		On / Off	Switches the cooler.
Cooling fan		On / Off	Switches the cooler fan. Sometimes it is an advantage to switch off the cooler fan temporarily to reduce vibrations
Correction confirmation range: area n	Line scan camera	Integer number	The checking which is done prior to the correction data acquisition is done in an area

end			whose end position is specified here
Correction confirmation range: area n start	Line scan camera	Integer number	The checking which is done prior to the correction data acquisition is done in an area whose start position is specified here
Correction confirmation range: No. of areas	Line scan camera	Integer number	The checking which is done prior to the correction data acquisition is done in the following number of areas
Cycle Number		Integer number	Number of cyclesj
Data bit	Generic-Cam	Integer number	Number of Bits per Pixel for acquisition
Data valid	Generic-Cam	True / False	Sets the data valid flag of the frame grabber. Only valid for Camera Link
Defect pixel mode		On / Off	Correction of defect pixels
DSP commands			Defines parameters provided by a DSP inside the camera
EB-Gain	EB camera	Integer number	Sets the voltage on an electron bombarded CCD.
EM gain protect after frames (1-255, 0=off)	EM-CCD Camera	Integer number	EM protection feature triggers after n frames if the Warning level is exceeded
EM gain warning alarm	EM-CCD Camera	On / Off	Specifies whether the camera should raise an alarm when the input intensity is too high
EM gain warning level	EM-CCD Camera	Integer number	Specifies the sensitivity of the EM gain warning. Higher number means higher sensitivity
EMG		Integer number	EMG specifies the gain of an electron multiplying device inside a CCD camera.
Exposure time - Exposure		Time in h, m, s, ms, us, ns / External / Controlled by PC	The exposure time is the time the CCD camera is sensitive to light. This timing is dependent on timing and trigger mode and electrical signals applied to the camera controller or head. In internal mode and in special other externally triggered modes like the edge trigger mode this time is just specified as a time in physical units (e.g. seconds). In other cases like level trigger modes it is defined by the length of the electrical pulses. In again other cases it is defined by the PCs clock or by the timing of external events.
Frame average	EM-CCD		A special mode to integrate

	Camera		frames to reduce the noise
Frame time		Any time in physical units	Interline CCD cameras: For interline cameras exposure and readout can be performed simultaneously. For exposure times <= readout time the frame time is always the readout time. For exposure times > readout time the frame time is always the exposure time. Full frame transfer CCDs: For full frame transfer CCD cameras exposure and readout is always done separated. This means frame time = exposure + readout time. CCIR/EIA video type cameras: The frame time for standard video readout cameras the frame time is always fixed (40 ms for CCIR and 33 ms for EIA).
Gain - Amp gain - CCD camera analog gain		Low / high / super-high - 0-255 - 0 / 1 or 0 / 1 / 2	Gain or Amp gain specifies the setting of an analog amplifier inside the CCD camera controller or head. Sometimes the range of settings depends on other parameters like scan speed.
Gain table	Line scan camera	Integer number	Selects a predefines gain table for sensor gain
Gate delay		Time in h, m, s, ms, us, ns	The delay time after a gate pulse. Specified in physical units.
Global reset trigger mode	sCOM camera	Rolling reset / Global reset	Trigger mode for sCMOS camera
Height (centered)	Subarray	Integer number	Specifies the height of the subarray. The area is centered on the Chip
Hexadezimal Input	Generic-Cam	True / False	If this control is selected the inputted data is interpreted as Hex values
High dynamic range mode		On / Off	Specifies whether High dynamic range mode is used during camera acquisition
High voltage		On / Off	Applies or switches off high voltage
H-Offset	Subarrray	Integer number	Horizontal offset
Hor. Binning		Integer number	Binning factor in horizontal direction

H-Width	Subarrray	Integer number	Horizontal width (Setting used only in subarray scan mode)
Image height [Pixel]	Generic-Cam	Integer number	Number of pixels in Y-Direction
Image width [Pixel]	Generic-Cam	Integer number	Number of pixels in X-Direction
Interval Time	Generic-Cam	Floating point value	Specifies the interval time for the output in case of Pattern
Light mode		Low/High Or 0-1	Two different settings of the camera can be selected. In Light mode **Low** (= 0) the camera works with reduced sensitivity but maximum dynamic range, while in Light mode **High** (= 1) the camera works with maximum sensitivity at a slightly lower dynamic range.
Line frequency	Line scan camera	Floating point number	Specifies the line frequency of the line sensor
Line sensor speed	Line scan camera	Floating point number	Specifies the line frequency of the line sensor in units of the conveyer belt movements under the assumption of square pixels
MCP - MCP gain		Integer number	MCP gain specifies the setting of a high voltage applied to a photocathode inside an image intensifier placed on the front of a CCD camera.
Mode		Internal Trig. / Ext.Trig./Time / Ext. Trig./ Event / Ext. Trig./Level / Ext. Trig./Stop	Mode is comparable to a combination of Timing and trigger mode. These modes are special trigger modes of the C4880 standard camera. Please refer to the camera manual and the related timing diagrams for details.
Mode 0 (Bin0)	Generic-Cam	High / Low	Outputs a TTL level on the frame grabbers Control 0 line
Mode 1 (Bin1)	Generic-Cam	High / Low	Outputs a TTL level on the frame grabbers Control 1 line
Mode 2 (Int/ Ext)	Generic-Cam	High / Low	Outputs a TTL level on the frame grabbers Control 3 line
Negative Logic	Generic-Cam	True / False	Outputs the trigger in negative logic (active=low)
New types	Flat panel	On / Off	Sometimes Flat panels have older and newer types of the same device. Newer types normally have a Lemo connector at the camera front side.
Offset		Integer number	Offset specifies an analog which is subtracted to the analog signal of the CCD chip. It is

			normally used in combination with gain of amp gain.
On Chip Amp	EM Camera	EM readout / CCD readout	Readout mode of an EM CCD camera.
Optical Black		On / Off	Optical black defines whether black lines and columns on the left and top side of the CCD (normally covered by black cover) are readout
Output mode	Generic-Cam	Area / Line	Specifies how to interpret the output of the camera
Panel switch		On / Off	Specifies whether a small panel on the front side of the CCD camera controller is active of not. If Off the parameters can be specified only by software.
Photon imaging mode		No / middle / high	A mode to increase sensitivity under very weak light conditions (patented by Hamamatsu Photonics KK)
Port	Generic-Cam	Integer number	COM port number for serial communication
Pulsewidth	Generic-Cam	Floating point value	Specifies the pulsewidth time for the output in case of Pattern
Readout direction	TDI camera	Forward / Reverse	Specifies the readout direction of a TDI camera
Readout Time	Generic-Cam		Specifies the readout time. This is used only for determining the acquisition strategy and will also be saved in the image header.
Recursive filter - Rolling average		On / Off	Starts or stops a recursive filter function inside the camera
Recursive filter number - Rolling average (number)		Integer number	Defines the recursive filter number fro the Recursive filter operation
ROM version - ROM		Text	Displays the ROM version
Scan Area		Two integer numbers	Number of pixel in both directions (x and y)
Scan Mode		Normal / Superpixel / Subarray / Interlace / Outline	Scan mode defines how the content of a CCD chip is read out. Normal: The whole CCD chip is read out pixel per pixel Superpixel: A special binning mode where a square number of

			pixel is binned (e.g. 2 x 2, 4 x 4). This function can be used to increase camera sensitivity, increase the readout rate (frame rate) and reduce the amount of data. Subarray: Only a user-predefined area of the CCD is read out. This function can be used to reduce the amount of data and speed up the readout, if only a part of the image is necessary for analysis. Interlace: A mode where every second line is read out. Outline: A mode where the full chip is read out with low resolution and high frame rate
Scan speed - Readout speed		High / Low or High / Low / medium or 0 / 1 (0=fast, 1=slow)	Speed of CCD readout. This is mainly determined by the pixel clock of the camera. Fast readout has the advantage of high frame rate, whereas slow readout results in high dynamic range. Sometimes slow readout is called high precision mode. Cameras with slow readout are also called slow-scan cameras.
Sensitivity		On / Off	Switches on or off the sensitivity parameter of a camera
Shading control		On / Off	Specifies whether an analog shading corrector is active on the front side of the camera.
Shading correction		On / Off	Calculates a shading correction inside the camera based on a specified shading image
Shutter control		"Auto" / "Open" / "Close" / "Close on readout"	Control how a mechanical shutter which is mounted on the front side of the CCD behaves Auto: Always closed expect during camera exposure Close: Closed Open: Opened Close on readout: Always open, except during readout of an image
Spot noise reduction	EM-CCD Camera		A special mode to reduce the spot noise
Start mode	TDI camera	Trigger once / Trigger every frame	Specifies how the trigger input affects the image acquisition
Subarray settings			Settings describing the subarray

Subtype	Flat panel	String	Defines which type of Flat panel is used. Normally this type is detected automatically.
Tap Config	Generic-Cam	1CHANNEL_L2R / 2CHANNEL_SEP_TAP_CONVERGE / 2CHANNEL_HALFTOP_HALFBOTTOM / 2CHANNEL_HALFTOP_HALFBOTTOM_STARTCENTER / 2CHANNEL_SEP_TAP_L2R / 3CHANNEL_SEP_TAP_L2R / 4CHANNEL_SEP_TAP_L2R / 8CHANNEL_SEP_TAP_L2R / 3CHANNEL_PARALLEL_L2R / 1CHANNEL_10Tap	Specifies the Tap configuration of the camera output. Not all grabbers support all Tap configurations. Example: The C9300 outputs two tap in a converging way, the needed tap configuration is therefore: 2CHANNEL_SEP_TAP_CONVERGE
Target temperature		Any temperature	The target temperature the cooler should reach and stabilize during cooling.
TDI mode	TDI camera	Area / TDI	Specifies the operation mode of the TDI camera
Timing mode		Internal / External - Internal / External Grb / External Lemo - Internal / External Edge 1/2/3 External Level 1/2 / External Gated -	The timing or timing mode defines whether start and stop of an exposure is defined internally (in the camera) or by an external electrical signal Internal defines the timing inside the camera where External starts/stops exposure by an electrical signal. External-Grb defines the timing by the connected frame grabber External Lemo defines the timing by an electrical signal inputted by a Lemo connector External Edge 1/2/3, External Level 1/2 and External Gated are special timing modes dedicated to the C9266 X-ray dental sensor and C11512 InGaAs sensor
Trigger	Generic-Cam	Low / High / Pattern	Outputs a level or pulse train on the specified output. Depending on the Alternate trigger and the frame grabber this can be Control 2 or another line.
Trigger edge	USB 1.1 Mini-	RISING_EDGE / FALLING_EDGE /	Specifies the type of edge for triggering

	spectro meter	NO_FUNCTION	
Trigger input delay		Time in physical units	Trigger Delay for triggering the camera.
Trigger Mode		Internal / External / External Start / Edge trigger / Level trigger / Fast repeat mode (PIV) / Synchronous / Synchronous readout / Sync trigger / External + constant exp.time	This parameter defines how a camera reacts on an external trigger. Internal: exposure is defined by the camera External: exposure is defined by an external pulse Edge: Starts exposure with a (rising or falling according to polarity) edge of an electrical signal (Normally a TTL signal) Level: Exposure starts with an edge (falling or rising according to polarity) and stops with the inverse edge of an electrical signal (Normally a TTL signal) PIV: PIV stands Particle image velocitometry. With an edge (falling or rising according to polarity) of an electrical signal (Normally a TTL signal) two images are acquired and readout within short time. Synchronous: Every trigger starts a new exposure, the exposure lasts until the next trigger.
Trigger number		Integer number	Number of triggers applied to the CCD camera before it readouts an image
Trigger Output Delay [s] - Ext. Output Delay [s]		Floating point number	Delay of the trigger output
Trigger Output Polarity - Ext. Output Polarity		Positive / Negative	Polarity of the trigger output
Trigger output reference	sCMOS camera	End of sensor readout / Beginning of VSync / Beginning of HSync	Specifies the reference of the output signal
Trigger Output Width [s]		Floating point number	Width of the trigger output

- Ext. Output Width [s]			
Trigger polarity - Polarity		Positive / Negative	Defines the active level of an electrical signal starting a camera exposure. If Trigger polarity is negative a falling edge (transition from high to low) starts image exposure (provided that the camera is switched to edge trigger mode).
Trigger source		BNC / D-Sub / Digital I/F / Multiport - BNC Only / I/O Only / BNC And IO	BNC: A BNC connector normally at the rear side of the camera controller D-SUB: A 9 pin D-Sub connector at the rear side of the camera controller Digital I/F: An electrical signal normally connected from the digital data connector of the camera to the frame grabber Multiport: A 4 pin Hirose type connector at the camera head, which eventually has other features on other pins. BNC Only / I/O Only / BNC And IO are values associated to the C11512 InGaAs sensor
Ver. Binning		Integer number	Binning factor in vertical direction
V-Offset	Subarrray	Integer number	Vertical offset (Setting used only in subarray scan mode)
Vol. gain.		Integer number	Displays the potentiometer setting for gain
Vol. Offs.		Integer number	Displays the potentiometer setting for offset
V-Width	Subarrray	Integer number	vertical width (Setting used only in subarray scan mode)
Width (centered)	Subarray	Integer number	Specifies the width of the subarray. The area is centered on the Chip
X direction (pixel)		Integer number	Size of the acquired image in X-direction
X-MaxArea [Pixel]	Generic-Cam	Integer number	Size of Image outputted in X-Direction (Image width [Pixel] can be smaller than this)
X-Offset [Pixel]	Generic-Cam	Integer number	Number of Offset pixels in X-Direction
Y-MaxArea [Pixel]	Generic-Cam	Integer number	Size of Image outputted in Y-Direction (Image height [Pixel] can be smaller than this)

Y-Offset [Pixel]	Generic-Cam	Integer number	Number of Offset pixels in Y-Direction

The following parameters can be found on the camera acquisition dialog. They are however no parameters which are contributed by the cameras behavior, but are parameter which are due to the acquisition process, therefore we call it acquisition parameters.

# of exposures	Integer number	In analog integration mode this parameter defines how many frames are summed up in memory
# of triggers	Integer number	Number of streak triggers with trigger handshake during the acquisition of a single CCD image
(Photon counting) Threshold - Threshold2	Integer number	Threshold above parts in the image are regarded as photon spots
Above threshold	Value ranging from 0 to 100 [%]	Displays the percentage of pixels which are above the photon counting threshold in the raw image
Automatic (Bundle height for scrolling live display)	On / Off	If this parameter is selected the number of lines which are readout as a bundle in Scrolling live display is calculated automatically according to the readout speed
Bundle height (for scrolling live display)	Integer number	This parameter specifies the number of lines which are readout as a bundle in Scrolling live display.
Clear on Start	Checked/ Unchecked	This parameter defines whether the currently selected image should be cleared when starting image acquisition. If this parameter is not selected one can continue to acquire data starting with the data in the currently selected image
Distance X-Ray tube <-> object	Floating point number	X-Ray line sensors: Distance of the X-Ray tube to the object
Distance X-Ray tube <-> sensor	Floating point number	X-Ray line sensors: Distance of the X-Ray tube to the sensor
Flip image right to left in reverse scanning	True / False	If a TDI sensor is readout in reverse direction this function flips the content of the outputted data right to left. This preserves the orientation of the image data, otherwise it becomes mirror-inverted
Frame bundle mode	On / Off	A mode which outputs several images as one bundle
Frame bundle number	Integer number	Number of bundles used for frame bundle mode
Frame grabber trigger active	Checked/ Unchecked	This parameter defines whether acquisitions from an analog camera should start with an electrical signal applied to

		the FG trigger input (FG=frame grabber). This parameter applies only to standard video camera signals.
Frame trigger	Checked/ Unchecked	This parameter defines whether acquisitions from a line sensor or TDI camera should start with an electrical signal applied to the frame trigger input.
Integrate after trig. - Integrate after trigger	Integer number	This parameter defines whether the system should average a specified amount of frames after the reception of a trigger.
Lines per image - No. of acquired lines per image	Integer number	This value specifies the number of lines which are readout as one image for line scan or TDI cameras. As such cameras do not have a frame-valid signal this is arbitrary and can/must be specified by the user
Magnifying geometry	On / Off	X-Ray line sensors: This option allows to calculate the line speed of a line sensor starting from real values for the distances of X-Ray tube, sensor and object
Number (for Rolling average) - Number (for recursive filter)	2- 255	Indicates the strength of the Rolling average function. The higher the number the stronger is the noise reduction but the more lag is introduced to the image.
Real time background subtraction - RT backsub - RTBS	On / Off	Real time background subtraction is a function which continuously subtracts a background image prior to displaying any new image in live mode
Real time shading correction - RT shading correction - RTSH	On / Off	Real time shading correction is a function which continuously divides a shading image prior to displaying any new image in live mode
Rolling average - Recursive filter	Checked/ Unchecked	An image processing function which reduces the noise by combining the current image with the previous image (Live mode only).
Scrolling live display	On / Off	This option is only valid for line scan and TDI cameras. Normally a new image is displayed as soon as all lines of one image are readout.

		If this option is selected it behaves as follows: Small bundles are readout and added to the bottom of the image which is continuously scrolled to the top
Speed of conveyer belt	Floating point number	X-Ray line sensors: Real speed of the conveyer belt.
Start acquisition for sequence mode	"Next field", "Odd field", "Even field"	This parameter refers to images acquired by an analog CCD camera. It defines whether during sequence acquisition of full frames should start with an odd field an even field or the next field.
Type of displayed intensity data during measurement	Average / Maximum / Minimum	X-Ray line sensors: Specifies which intensity will be displayed during data measurement:
Wait for 2nd Frame in Acquire mode	Checked/ Unchecked	This parameter defines whether for acquisition of flat panel images in acquire mode the system should ship the first frame and record only the second

Acquisition modes

Basic operations

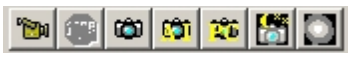
Acquisition modes

Four image acquisition modes (Live, Acquire, Analog Integration and Photon Counting) can be controlled from the camera acquisition dialog.

Please note: Not all cameras support all these acquisition modes.

There are two ways to open this control:

1. Choose the desired acquisition mode from the **Acquisition** menu.
2. Click on the desired acquisition mode button as described below



	Live mode	If the Acquisition dialogue is not opened, it will be opened as you click this button for the first time. If you click it while the Live mode dialogue is open, image acquisition in **Live** mode will be started. The acquisition parameters as shown in the Live mode dialogue are used.
	Freeze Live mode	**Live** mode stops. The last image will be stored.
	Acquire	If the Acquisition dialogue is not opened, it will be opened as you click this button for the first time. If you click it while the Acquire mode dialogue is open, an image acquisition in **Acquire** mode will be executed. The acquisition parameters as shown in the Acquisition mode dialogue are used.
	Analog integration	If the Acquisition dialogue is not opened, it will be opened as you click this button for the first time. If

		you click it while the Analog integration mode dialogue is open, an image acquisition in **Analog integration** mode will be executed. The acquisition parameters as shown in the Analog integration mode dialogue are used.
	Photon counting	If the mode dialogue is not opened, it will be opened as you click this button for the first time. If you click it while the Photon counting mode dialogue is open, an image acquisition in **Photon Counting** mode will be executed. The acquisition parameters as shown in the Photon counting mode dialogue are used. See.

The acquisition buttons work different depending on the display status of the acquisition window:

If the window is closed, it will be opened by clicking one of the buttons.

If the window is already opened, the corresponding acquisition function will start after pressing an acquisition button. The acquisition will be made with the parameters set in the corresponding tab control.

The camera acquisition dialog has four tabs to control the different acquisition modes.

The camera and acquisition parameters of every acquisition mode is stored internally and reactivated if the acquisition mode is selected again.

The camera acquisition dialog can be changed in its size using the two pushbuttons on the right side of the dialogue.

If you want to see the whole window with all options, you have to choose the largest size. However after you have finished initial settings, you may not need to see all setting features of the control. Then you can make it smaller and display just the controls you need for your work (e. g. start acquisition and set exposure).

If the Acquisition Dialog is opened once, you can switch between the different modes either by selecting the desired mode from the main menu or by selecting the tab corresponding to the desired mode.

Each acquisition can be started by a hot-key and stopped by pressing the ESC key.

Hot-keys for start of an acquisition are:

Ctrl +L Live
Ctrl +F Freeze

Ctrl +A Acquire
Ctrl +I Analog integration
Ctrl +C Photon counting

Live

Live

Live mode is a mode in which images are acquired continuously. It is intended for monitoring images with maximum speed. It differs from other acquisition modes from display window handling. Live images are always displayed in the same window, while in other modes each new image can be displayed in a new display window.

The acquisition speed is displayed in the status bar. This feature can be used to control whether the camera is operated correctly.

Image quality can be improved by using real time background subtraction (RTBS), real time shading correction (RTSH) and Rolling average.

Acquire Mode

Acquire Mode

Acquire mode is very similar to Live mode Single image with two exceptions:

1.) It can contain different camera parameters as the Live mode. Thus it is easy to use two different camera parameter sets just by switching back and forth from Live to Acquire mode.

2.) Acquire mode does not use always the same window. Normally with every new acquisition the measurement data is written to a new image and displayed in an individual window. This prevents overwriting of already acquired data.
Note: There is an option in the images options called Acquire always to the same window . If this option is checked all new acquisitions are directed to one image and are displayed in the same window which means that the previous image data is overwritten without warning.

Difference between Live and Acquire mode

Difference between Live and Acquire mode

Acquire mode is mainly intended to acquire measurement data whereas live mode is mainly intended for checking and adjustment purposes. In the case of a so called dual scan cameras like the C4880 and ORCA II there is an additional feature associated with the different acquisition modes:

Live mode and photon counting mode is operated with fast scan mode whereas Acquire mode and Analog integration mode is operated in slow scan mode. This enhances the meaning of Live mode as a fast operating mode for adjustment and checking purposes where Acquire mode is a measurement mode in which the camera is used in a high precision mode with maximum bit range.

Note: The feature that Live and Photon counting mode is operated in fast scan mode and Acquire and Analog integration is operated in slow scan mode is only available if the camera is used with internal drivers. If the camera is operated by a DCam module the setting of scan mode is done in the camera options and is valid for all acquisition modes.

Analog Integration

Basic operations > Acquisition modes

Analog Integration

Analog Integration is a mode where a number of images from the camera are accumulated in the frame memory up to 16 or 32 bit depth. (16bit/32 bit).

The acquisition speed is displayed in the status bar. This feature can be used to control whether the camera is operated correctly.

Photon Counting

Basic operations > Acquisition modes

Photon Counting

Photon Counting is a mode in which single photon events are added up in the frame memory. If the signal integration time is sufficiently long, a very high signal-to-noise ratio can be achieved. This mode also effectively suppresses certain crosstalk effects inherent to some image intensifiers and streak tubes. A dynamic photon counting mode allows temporal analysis of photon counting images.

Note: This mode is only useful if an image amplification device such as an image intensifier or a streak tube allows to see the effect of a single photon. Most cameras do not have this feature!

The acquisition speed is displayed in the status bar. This feature can be used to control whether the camera is operated correctly.

See also the chapter Photon counting in this document for details.

Camera data types and data storage

Basic operations > Acquisition modes

Camera data types and data storage

Depending on the data delivered by the camera and the acquisition mode the result image will be stored in different types of images.

The data type of cameras range from 8 to 16 bit.

Data type of cameras

In practice the following data types can be delivered from the camera:

8, 10, 12, 14, 16 bit (all unsigned values)

According to the data type possible output values are

Camera Data Type (bit)	Value range

8	0 to 255
10	0 to 1023
12	0 to 4095
13	0 to 8191
14	0 to 16393
16	0 to 65535

Storage types

Image data is stored in four different types:

8 (unsigned), 16 (unsigned), 16 (signed) and 32 bit (signed)

According to the data storage type possible the following values can be stored

Storage (bit)	Value range
8 (unsigned)	0 to 255
16 (unsigned)	0 to 65535
16 (signed)	- 32768 to 32767
32 (signed)	- 2.147.483.648 to 2.147.483.647

Depending on the acquisition mode and some related parameters the following storage types are used:

Live and Acquire mode

Camera data	Option Create 32 bit data when camera has 16 bit	Storage type
8	n.c.	8 (unsigned)
10, 12, 13, 14	n.c.	16 (signed)
16	False	16 (unsigned)
16	True	32 (signed)

Analog integration mode

Camera data	Option Create 32 bit data when camera has 16 bit	Option Use 32 bit in Analog integration	Storage type
8, 10, 12, 13,14	n.c.	False	16 (signed)
16	False	False	16 (unsigned)
16	True	False	32 (signed)
8, 10, 12, 13, 14, 16	n.c.	True	32 (signed)

Photon counting images uses 16 bit as data storage type normally, if the option 32 bit in Photon counting is set 32 bit is used.

Corrections

Basic operations

Corrections

Corrections are used to compensate artifacts of CCD cameras, optics and other components used in the system. See also the chapter corrections in this document for more details.

Background subtraction correction

Basic operations > Corrections

Background subtraction correction

Most cameras outputs a nonzero signal even if they are not illuminated with light.

This has mainly two reasons:

1.) Image data is normally digitized by an A/D converter which outputs only positive numbers (including zero). Therefore it is an advantage to adjust the A/D offset in a way that already with no illumination there is a nonzero output. Otherwise small signals still leads zero as an output and cannot be measured. Additionally every camera has a so called fixed pattern which is present in every image. To subtract this fixed pattern a background subtraction can be used. However if the signal is zero for low intensities a dark image does not contain the fixed pattern and consequently cannot be subtracted.

2.) Even with no illumination the sensor accumulates some charges which leads to a nonzero signal

As a consequence the most important correction method is a function which subtracts a dark data from the measurement data. See also the chapter Corrections - Background Subtraction in this document.

Standard background subtraction

Basic operations > Corrections > Background subtraction correction

Standard background subtraction

Standard background subtraction is a function which subtracts a dark image from the given data. This is always executed after the image acquisition as a post process. The dark image can be either directly acquired from the camera or it can be read from an image file. There is an option to automatically call this post process after the image acquisition. This automated process is always called when an image acquisition finishes. This is:

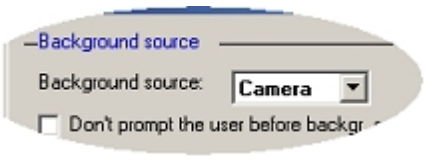
In Live mode when the live mode has been freezed.

In Acquire mode when the image is completely acquired.

In Analog integration mode and photon counting mode when all images which should be summed up in memory are acquired

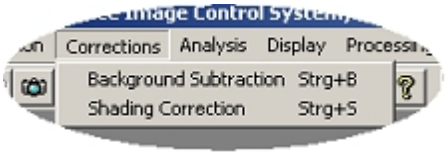
To operate background subtraction from camera

1.) Select Camera as the background source in the background options.



2.) Acquire an image

3.) Start background subtraction by either executing background subtraction from the menu:



- or -
Execute the Background subtraction icon on the toolbar:

RTBS (real time background subtraction)

Basic operations > Corrections > Background subtraction correction

RTBS (real time background subtraction)

Sometimes a background subtraction makes a so big difference on the image result that the user wishes that such background subtraction is also performed during live mode. This is a feature which can be called directly from the camera acquisition dialog. The data used as a background image can be either come from the camera directly or from an image file.
To execute real time background subtraction proceed as follows

1.) Start Live mode

2.) Select RTBS on the camera acquisition dialog.

3.) 

4.) If there is no image in the background buffer which is the case at program start get new background data:
Click Get BG Data.

This puts the next acquired image in the RTBS background buffer. Whenever you want to use a newer background image click Get BG Data.

Note: Real time background subtraction is also very useful to eliminate unwanted signal from an image.

Camera provided function

Basic operations > Corrections > Background subtraction correction

Camera provided function

Some cameras have a built in background subtraction. In such cases the software only controls the camera feature but does not execute a background subtraction as an own function. Thus controlling the built in background subtraction with additionally executing the background subtraction functions from the software may lead to undesired results.

Cameras with built in background subtraction feature are:

- The C9100-13 (ImagEM)

Shading correction

Basic operations > Corrections

Shading correction

The **Shading Correction** command corrects intensity non-uniformities of an image. In principle this is done by a pixel by pixel division of the intensity in the measurement image and the shading reference image. See also the chapter Corrections -Shading correction in the document.

To perform shading correction proceed as follows:

1.) Record a shading reference image. This image should represent the sensitivity distribution of the system.

2.) Perform background subtraction on this shading reference image.

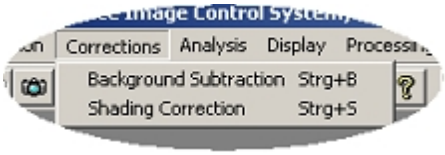
3.) Save the image to hard disk.

4.) Specify the image as the shading image in the shading correction options. To do this click to the pushbutton Get at the left side of the edit field for the shading file.

5.) Acquire your image data which you want to be shading corrected.

6.) Perform background subtraction on this image.

7.) Start Shading correction by either executing shading correction from the menu



- or -

Execute the Shading correction icon on the toolbar:

Note: Item 1) 4) have to be performed only once if the system sensitivity does not change

Camera provided function

Basic operations > Corrections > Shading correction

Camera provided function

Some cameras provide a shading correction by firmware.

Cameras with built in shading correction feature are:

- The C9100-13 (ImagEM)

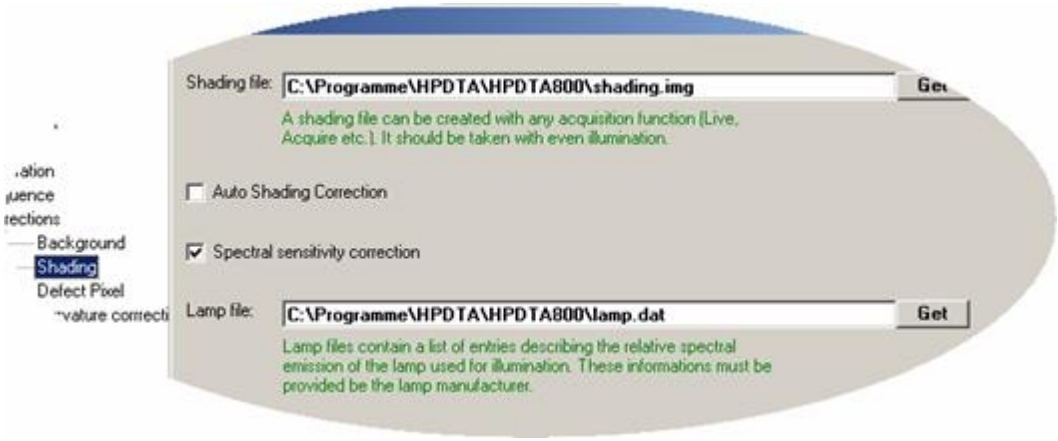
Spectral sensitivity correction

Basic operations > Corrections

Spectral sensitivity correction

If a spectrograph is used in the measurement the data is influenced by the spectral intensity of the illumination lamp. In some cases a uses has the wish to include the no uniformity of the intensity along the spectral axis in the shading correction. This is done by a spectral sensitivity correction on the basis of a so called lamp file. See also the chapter Corrections Spectral Sensitivity Correction in the document.

To operate the spectral sensitivity correction specify a lamp file and activate the option Spectral sensitivity correction.



When ever a shading correction is performed, the spectral sensitivity correction is applied.

Curvature correction

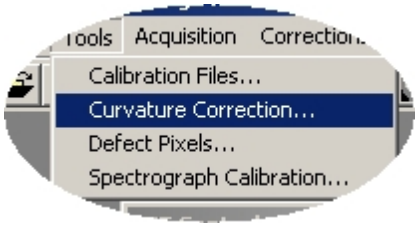
Basic operations > Corrections

Curvature correction

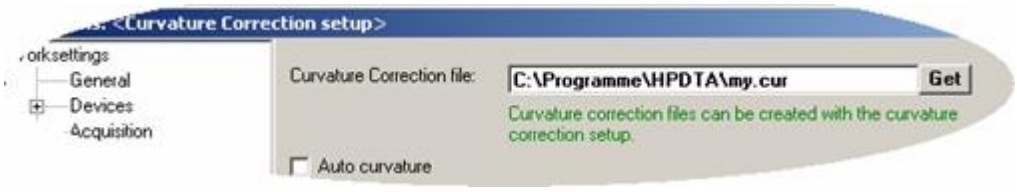
The Curvature Correction command corrects geometric distortion of an image acquired with synchroscan streak cameras with synchronous blanking function. See also the chapter Corrections Curvature Correctionin this document.

To activate curvature correction proceed as follows:

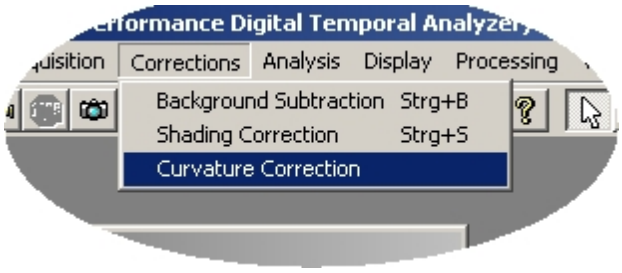
Create a curvature correction file with the Curvature correction tool and save it to a file. See the chapter Curvature correction Tool.



Specify this file in the curvature correction options.



Start the curvature correction by executing the curvature correction menu:



Defect pixel correction

Basic operations > Corrections

Defect pixel correction

This function corrects defective pixel of a sensor by replacing them with not defective neighbors. Defects in this sense can be either single pixels complete lines or complete columns. A defect is regarded as either a hot pixel, which has too high intensity when not illuminated or a dead pixel which has too low intensity when illuminated. See also the chapter Corrections Defect Pixel Correctionin this document.

To activate the defect pixel correction proceed as follows:

1.) Create a defect pixel correction file by using the defect pixel correction tool and save it to a disk file. See the chapter Defect pixel correction tool.

2.) Specify the name of the defect pixel file in the defect pixel correction options and activate the checkbox Defect pixel correction:

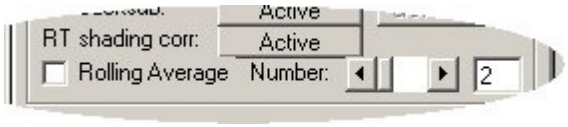
With every new acquisition the data is automatically corrected according to the information in the defect pixel file.

Rolling average

Basic operations > Corrections

Rolling average

While all the a.m. corrections improve the image quality there is another operation which also improves image quality without being a correction in the strict sense: It is the **rolling average** function which is available in live mode only.



Rolling average is an image processing function which reduces the noise by combining the

current image with the previous image (Live mode only).

The number which can be set from 2 t o255 indicates the strength of the **rolling average** function. The higher the number the stronger is the noise reduction but the more lag is introduced to the image.

Saving and loading images

Basic operations

Saving and loading images

This topic describes how to save or load images. Please see the Appendix Image File Formats for details.

Saving images

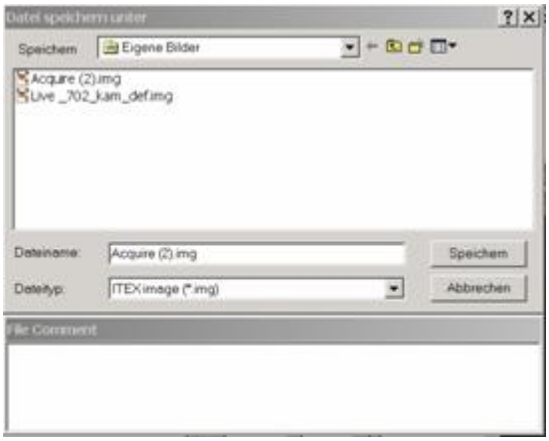
Basic operations > Saving and loading images

Saving images

*The **Save As**.. command opens a dialogue where you can input file name, file type, drive and directory name for the image file to be saved. The complete image will be saved.*
*The **Save ROI As**.. command saves the partial image within the currently selected rectangular ROI .*

Choose **Save As...** from the **File** menu.

If you want to save a part of the image only, you have to select the ROI **before** you open the **Save ROI As...** dialogue!



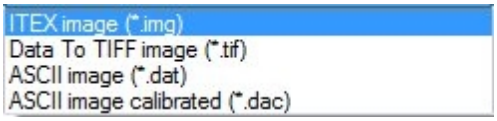
Save As... dialogue

If you select **Cancel** the program cancels the operation.

The dialogue behaves like a standard Windows dialogue. It allows to select the directory where the file shall be saved, to define new directories, to display the file list in different formats etc.

After selecting the desired directory, you have to type the desired file name in the **File name** textbox.
Note: The correct file extension (e.g. .tif or .img) will be automatically appended to the file name. If you type a file extension which is not identical to the file extension as defined by the file type (e.g. you type image.pix), the correct file extension will be appended automatically (e.g. image.pix.tif).

Image data are saved in a format as selected in the **Save as type** list. Following formats are supported:



Save as type list

See the appendix of a description of all these file formats.

In the text box below the **Save As..** or **Save ROI As...**dialogue you can input a comment. This comment will be saved to disk together with the image file and it can be used to identify the image later on.

Saving display

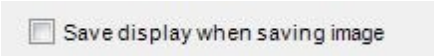
Saving display

This command allows saving images as they look like in 8 bit.

*The **Save As Display**.. command opens a dialogue where you can input file name, file type, drive and directory name for the image file to be saved. Warning: Only 8 bit will be saved. The **Save ROI As Display**.. command saves the partial image within the currently selected rectangular ROI . Warning: Only 8 bit will be saved.*

This command is useful for documentation. Please note: This function is not useful if the full amount of data should be saved. For this purpose please use the ***Save As..*** command.

If the image option Save display when saving images is set the display is automatically saved whenever an image is saved.



The filename is derived from the original filename in the following way:

Original filename: *filename.extension*

Display filename: *filename*_Disp.tif

Loading images

Loading images

This command allows loading and displaying an existing image file.

The **Open...** command pops up a dialogue similar to the **Save As...** dialogue. You have to select an image file type which you want to load and display. To select a file you can either input a file name in the file name text box or double-click on the filename in the file list.

If the selected file is part of an image sequence, the sequence, starting at the chosen file number will be loaded.

Following file types can be read by this program:

ITEX files and sequences, TIFF files and sequences (however not 24 bit color TIFF images), DPC files and DPC sequences.

File info

File info

As soon as you have selected a file, detailed information about the actually selected file will be displayed in the **File info** table below the dialogue. The content of this dialogue is same

as the **Image Status** display explained below.

Loading TIF images from other Hamamatsu applications

Loading TIF images from other Hamamatsu applications

When loading TIF images from other Hamamatsu applications like HoKaWo or HC-Image this software tries to extract as many informations from these Application and displays them in the usual way.

Corrections

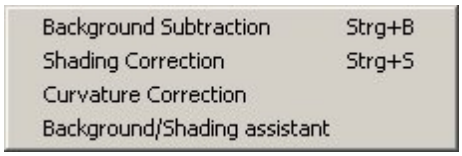
Corrections

This topic describes the details of all image correction methods.

Overview

Overview

In the corrections menu you find commands which are related to image data corrections:



The menu items which can be executed from the correction menu are:

Background Subtraction, Shading correction, Curvature correction and Background/Shading assistant

The Real time background subtraction and the real time shading correction can be invoked from the camera acquisition dialog.

The defect pixel correction is automatically performed once it has been activated in the defect pixel correction options or can be applied after image acquisition (offline defect correction).

A background/shading assistant can help you to handle background and shading corrections easily.

Background Subtraction

Background Subtraction

The **Background subtraction** command subtracts a background image from the current image in the frame buffer. How this is done is determined by the settings in the background correction options.

If you want to automatically subtract background after each acquisition, you can select the **Auto Backsub** item in the background correction.

In Live Mode there is also the possibility to perform Real time background subtraction (RTBS), which displays the corrected image after every single acquire image.

The Background subtraction function allows you to subtract the camera dark current from an acquired image. The function can also be used to subtract offset signals of other origin such as undesired background light or stray light.

Background subtraction can be performed either "from camera" or "from file" depending on the setting in the background correction options.

Background Subtraction from Camera

Corrections > Background Subtraction

Background Subtraction from Camera

When the option **Camera** is selected a new background image is acquired after each image acquisition and then subtracted from the acquired image. This means, the background image is taken after the data acquisition.

The background image is automatically acquired with the same parameters (such as exposure time and camera gain) as the acquired image. This method is easy to use and convenient if the exposure time is not too long. (In case of long exposure times you may wish to use the "from file" method instead.).

Following description refers to a configuration where a C4880 type camera (except C4880-8X and C4880-40) with a mechanical shutter is used.

The check box **Acquire image with open shutter** defines whether the C4880 shutter will be closed or opened during background acquisition. In most cases you will prefer that the shutter is closed automatically during background acquisition since this is the most convenient way. However, if you want to subtract also background light which has an external origin (such as stray light), you could disable this automatic shutter control by selecting the check box.

Following description refers to a configuration where an analog video camera or another camera without mechanical shutter (e.g. C3077, C4880-80, C4880-40 or C4742-95) is used.

If **Don t prompt the user before backgr. sub**is not selected the user is prompted to close any external shutter or switch off the illumination light or take a similar action to avoid that the light signal comes to the camera during background acquisition. If the option **Don t prompt the user before backgr. sub** is selected the user is **not** prompted to take any such action and Background subtraction immediately proceeds.

Background Subtraction from File

Corrections > Background Subtraction

Background Subtraction from File

In case of long exposure times, the "from camera" method may become inconvenient since it would take the same time to acquire the background image after every data acquisition. In these cases, it is preferable to save a background image to hard disk once and load it every

time it is needed. Of course, this makes sense only if you can assume that the same background image can be used for a series of data acquisitions (i.e. the acquisition conditions, like exposure time, will not change considerably.)

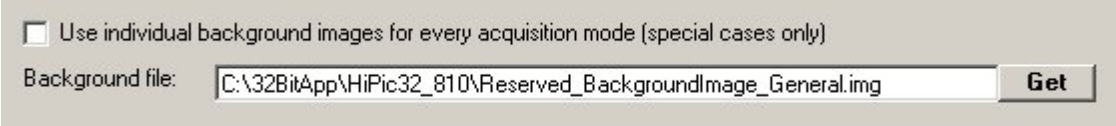
To perform background subtraction "from file" select the option **File**.

In some cases the readout parameters are different for different acquisition modes. In such cases you want to specify different files for the different acquisition modes (special case).

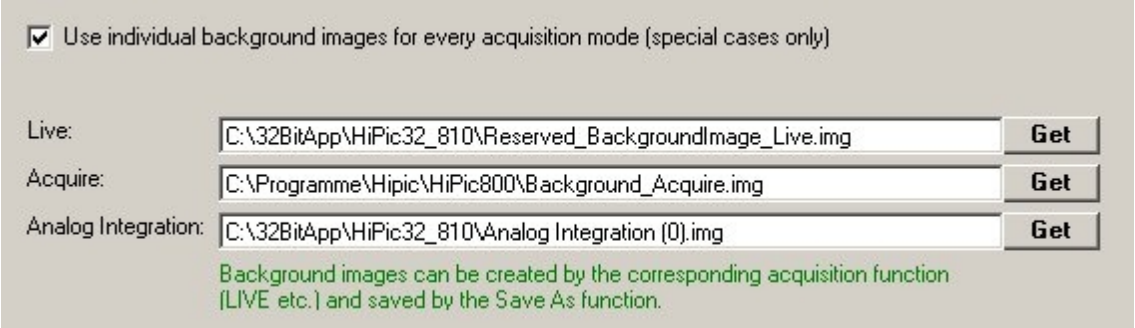
In many other cases (standard case), however, we do not want to specify several files for different acquisition modes and we assume that one file is suitable for every acquisition mode.

Note: When using the "from file" method the user must take care by himself that the background image contains suitable background data.

There is a checkbox where we can distinguish between these two cases. The default setting is that we do not distinguish between different acquisition modes and want to specify one single background file for every case.



Setting which uses one background file only (default)



Setting which uses different background files for different acquisition modes.

Press **Get** to open a file selection dialogue and select the desired file.

Save a background image

Corrections > Background Subtraction > Background Subtraction from File

Save a background image

To obtain a valid background image you simply take an image under background light conditions with the desired image parameters which you want to use for your measurement, e.g. correct exposure time, scan area, binning factor etc. Save this image by using the **Save as...** command.

Warnings

Corrections > Background Subtraction > Background Subtraction from File

Warnings

If the file which you defined as background image file (see below) does not fit to your measurement conditions (e.g. if the binning factors are different) you get an warning message when executing **Background subtraction** and you are prompted to prepare a suitable file and try background subtraction again.

In some case, e.g. if temperature conditions or exposure conditions are very much different for the image in the background image file and in the frame buffer, you will get a warning

message before the subtraction is performed and you can decide whether to proceed anyway or you want to prepare another background image. This should be just a hint from the program that the data may not be well suitable, but -as said above- the choice is yours.

Note: Background subtraction "from file" always subtracts pixels which have the same locations on the frame buffer one by one. Images which serve as background images should not have been shifted to another location (e.g. by loading it to a different location and saving it), and conditions like binning factors and optical black parameters should not differ.

Details About Background Subtraction

Corrections > Background Subtraction > Background Subtraction from File

Details About Background Subtraction

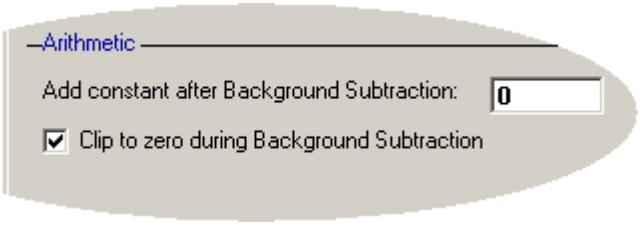
Note: This chapter contains information about how the background subtraction process works.

If the original image or parts of it and the background image have similar intensities and/or if the original image is completely dark on some areas, negative intensity values may result in several pixels after background subtraction. There are, however, some reasons not to allow negative values in the image:

- Negative intensity values often do not have a physical meaning (there is no "negative light intensity").
- Image processing programs often cannot interpret negative values correctly.

Considering all these arguments HPD-TA handles the question of negative values as follows:

The user can select if the images should be clipped to zero or not during background subtraction by selecting or deselecting the checkbox Clip to zero during background sub. Images with unsigned data type (8 bit unsigned and 16 bit unsigned) are always clipped to zero.



Considering Images which have acquired with a different integration count

Corrections > Background Subtraction > Background Subtraction from File

Considering Images which have acquired with a different integration count

This software allows integrating several camera images to one single image in Analog Integration mode. Software Versions prior to Version 8.1 did not allow to use images with different integration count for background subtraction, which leads to the necessity to acquire new background data for a different integration count. Version 8.1 and higher is now able to use any integration count number for the background image (as long as other parameters like image area or binning are suitable, as was described already earlier).

To increase precision and reduce noise it is recommended to use an integrated image as background image. The integration count should at least be (or better higher) as high as in the data which we want to correct.

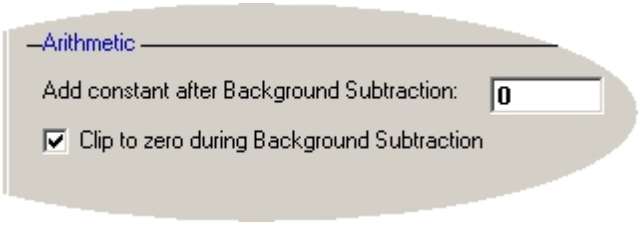
Constant

Corrections > Background Subtraction

Constant

You can add a **constant** during background subtraction process.

This is especially useful when normal acquisition modes are used and negative values would be clipped to zero. By adding a constant you will see the image noise correctly even in dark areas. To add a constant during background subtraction processing you simply enter the desired offset value in the edit box **Add constant after background subtraction**.



If you add a positive constant it may happen that the current bit range is exceeded. In this case the values are clipped to the maximum possible value within the bit range (e.g. 255 in 8 bit images, 1023 in 10 bit images and 4095 in 12 bit images). Therefore it is recommended to choose a constant not higher than necessary (the amount of noise is normally only a few counts). The constant is used for "from camera" type subtraction as well as for background subtraction "from file".

Real time corrections

Corrections

Real time corrections

There are two type of real time corrections: Real time background correction (RTBS) and Real time shading correction (RTSH).

Real time background correction

Corrections > Real time corrections

Real time background correction

Background subtraction is a method of subtraction images directly from live images prior to display it. It can be invoked on the Live tap of a camera acquisition dialog. If File is selected as the background source in the background options, the specified file is used as the default data for real time background subtraction.

The Get BG Data command acquires new background data from the camera. The toggle switch RT Backsub active starts the background subtraction process. or stops it.

Note: The Get BG Data command is only available when Live mode is running.

Let s assume you have selected File as the background source in the background options and you have acquired new data during real time background subtraction. If you then close the program or start another background subtraction you will be asked whether you want to save

this newly acquired background data permanently and use it for any subsequent background subtraction.

Real time shading correction

Corrections > Real time corrections

Real time shading correction

Once the real time shading correction (RTBS) is active, the real time shading correction (RTSH) becomes available. It uses the file specified in the shading correction options (see below for details). To start real time shading correction click to the toggle switch RT shading corr. Active

Shading Correction

Corrections

Shading Correction

The **Shading Correction** command corrects intensity non-uniformities of an image in the frame buffer. How this is done is determined by the settings in the shading correction options.

If you want to automatically correct shading after each acquisition, you can select the **Auto Shading** item in the shading correction options.

If your want to correct every image display in LIVE mode you can also use the real time shading correction (RTSH, see above).

Shading correction is a method to flatten a spatially non-uniform sensitivity of the complete imaging system.

Due to several reasons an imaging system can have a non-uniform sensitivity at different locations. The reasons may be uneven illumination, lens shading (vignetting) or different sensitivity of the CCD pixels. If an image intensifier is used, the image intensifier may have a spatially varying light amplification.

For streak cameras there are some special reasons which lead to such varying sensitivity: The input slit width may vary slightly (especially for small slit widths). The MCP of the streak tube may have varying amplification, there are two optics (input and output optics) which are introducing some shading and the streak sweep may be slightly non-linear which leads to a slowly varying signal amplitude along the time axis.

All these effects can be compensated by a multiplicative correction which we -by convention - call shading correction.

Get a Shading Reference Image

Corrections > Shading Correction

Get a Shading Reference Image

To be able to perform shading correction one must first acquire a shading reference image. A shading reference image is taken from a scene which is completely flat (homogenous illumination) within the field of view.

First, acquire this image by the imaging system, and then perform background subtraction on this image. Then you have to store the reference image using the **Save as...** command. Pay attention that the shading reference image should not have an intensity value of zero or close to zero at any pixel.

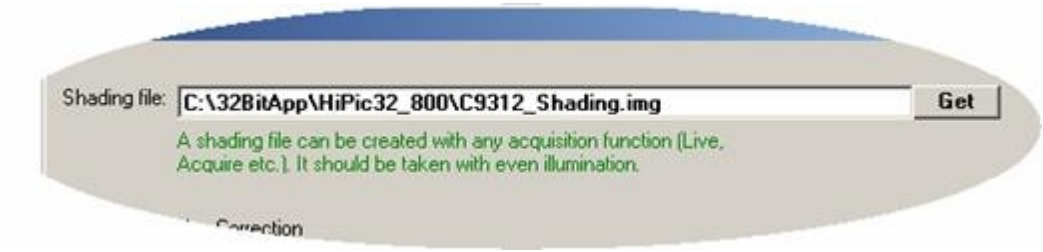
Sometimes, especially if one has to work under low light level conditions it may be very difficult or even impossible to obtain a shading reference image. In this case, shading

correction can not be applied.

Declare an Image as Shading Reference Image

Declare an Image as Shading Reference Image

Specify the image as the shading image in the shading correction options. To do this click to the pushbutton Get at the left side of the edit field for the shading file.



Algorithm of Shading Correction

Algorithm of Shading Correction

This chapter describes the algorithm behind the shading correction used in HPD-TA.

General

General

During shading correction the following calculation is performed:

$$C_{(x,y)} = \frac{D_{(x,y)} * K}{S_{(x,y)}}$$

C: Corrected image data (output image)
D: Uncorrected image data (input image)
K: Constant
S: Shading reference image

The calculation is performed with long integer arithmetic.

Constant K

Constant K

The constant **K** can be specified by the user. At locations where $K = S_{(x,y)}$ the data will not be changed, at locations where $S_{(x,y)} < K$ the image intensity will be enhanced after shading correction, and at locations where $S_{(x,y)} > K$ the image intensity will be reduced after shading correction.

Depending on the setting in the shading options either the Upper LUT value of the shading reference image is used as the constant K or this constant will be calculated automatically according to a well defined criteria (Recommended, Default).

When using the upper LUT value of the shading reference image the following is normally valid:
When setting the LUT values by the AUTO LUT function the upper LUT cursor will be set around the maximum value of the shading reference image. Normally shading data have a maximum intensity at the centre of the image and will slightly decrease at the image borders. Thus shading correction with a shading reference image where the LUT cursors have been set by the AUTO LUT function will keep the image intensity in the centre and enhance it at the borders. In almost every case this is the most convenient and easiest way of specifying the constant K.

When calculating the constant K automatically the average value of the center part (half size in both dimensions) of the shading image is used as the constant K.

Shading correction automatically accounts for chip type, frame-buffer type and binning factor, thus you can compensate an image which has been taken from the camera in normal mode with an image taken in 2 x 2 binning mode. Generally speaking the correction is always done with the pixels from the shading reference image which corresponds to the same location **on chip**.

The normal clipping is performed when the data exceed the current bit range. When zero is found in the shading reference image the corresponding pixel is not corrected (Shading reference images should not have zero values as a contents). The shading data should be background subtracted and should **not** be shading corrected itself. Otherwise an error message will be issued and the shading correction is not performed.

Spectral Sensitivity correction

Corrections > Shading Correction

Spectral Sensitivity correction

*Spectral Sensitivity correction is a more complex way of shading correction, especially designed for **correction of the spectral intensity characteristic** of a spectrometer and the camera detector for quantitative intensity analysis. While standard shading correction assumes that the light source used for shading image acquisition (in combination with a spectrograph) has a flat spectrum, the spectral sensitivity correction takes an uneven spectral emission of the light source into account. The spectral correction works along the horizontal axis of streak images.*

Before you can use the spectral sensitivity correction, you have to prepare a set of data (a table), which contains information about wavelength and correction factor of your light source. We call this function $L(\lambda_n)$.

For example you may use information about the absolute light emission characteristic of your light source supplied by the lamp manufacturer as a basis for this table. Such data is normally available for calibration lamps.

If we assume that the spectral range which you will use for analysis ranges from λ_{min} to λ_{max}, you have to make sure that the table of correction data $L(\lambda_n)$ where n= 1 to m follows following rules:

$\lambda_1 \leq \lambda_{min}$, $\lambda_n < \lambda_{n+}$, $\lambda_m \leq \lambda_{max.}$

The table must have the format (ASCII format)

...
λ_n, $L(\lambda_n)$
λ_{n+1}, $L(\lambda_{n+1})$
...

Algorithm of Spectral Sensitivity Correction

Corrections > Shading Correction

Algorithm of Spectral Sensitivity Correction

During spectral sensitivity correction the following calculation is performed:

$$C_{(x,y)} = \frac{D_{(x,y)} * K * L(\lambda)}{S_{(x,y)} * K_2}$$

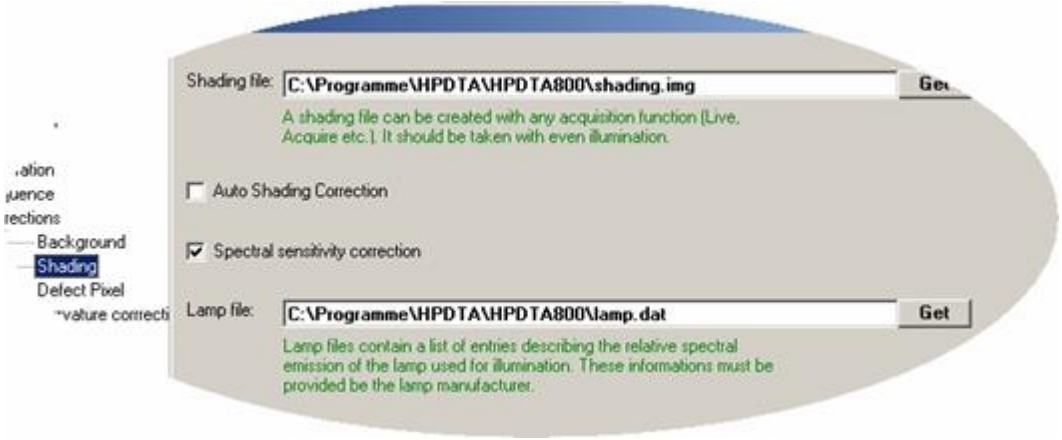
C:	Corrected image data (output image)
D:	Uncorrected image data (input image)
K:	Constant
K_2:	Constant
S:	Shading reference image
L(λ):	Lamp correction function as a function of wavelength
λ:	Wavelength in nm.

The calculation is performed with long integer arithmetic.

This means that when shading correction is performed, not only the system shading is corrected but also the dependence of emitted light intensity versus wavelength of your lamp is considered.

The proper correction factors are automatically calculated from the user defined table, in accordance with the actual spectrometer setting and scaling. Also K_2 will be automatically calculated by the program.

Before you enable the spectral sensitivity correction function you have to select the calibration file (lamp file) which you want to use by clicking the **Get** button and choosing the desired file.



If it is enabled, the correction will be carried out by the **Shading Correction** command.

Curvature Correction

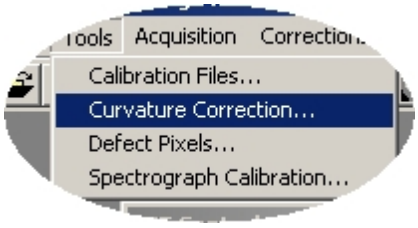
Corrections

Curvature Correction

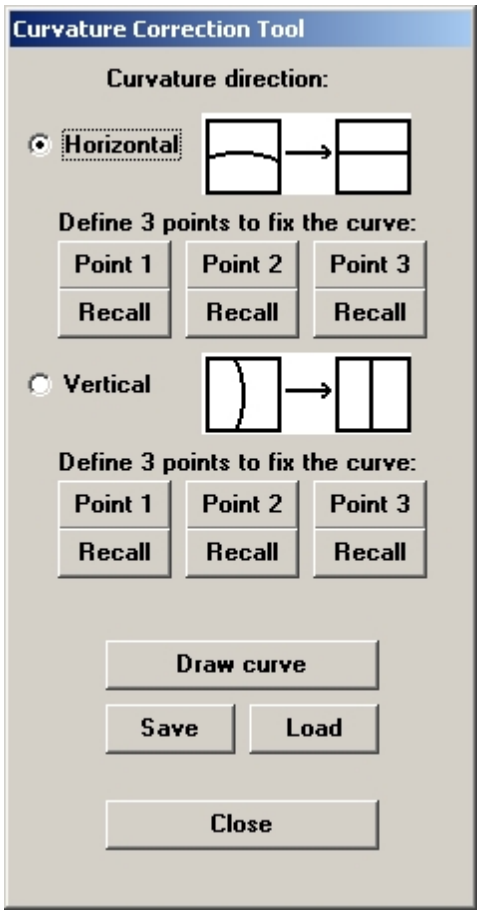
The Curvature Correction command corrects geometric distortion of an image in the frame-buffer. How this is done is determined by the settings in the Curvature correction Options.

In synchronous blanking mode of synchroscan operation the deflection of streak sweep is not completely straight, but elliptic. This results in a geometric distortion of the streak image in sweep direction. Curvature Correction corrects the distortion by compensating it with a parabolic correction curve.

Invoke the Curvature correction tool by executing the Tools - Curvature correction menu command.



The Curvature correction tool will appear on screen:



The Curvature Correction can be performed either in horizontal or in vertical direction. Choose the **Horizontal** method, if streak sweep is horizontal or **Vertical**, if sweep is vertical.

The geometric correction is done by using a parabolic correction curve. By specifying three reference points the parameters of the parabola can be specified.

First, you have to acquire a streak image with a signal which shows the curvature distortion. Use this image to define the correction parabola.

To enter the location of the reference points click the push-button **Point 1** first and select a point on the left or upper position of the distorted curve and click the left mouse button. Repeat this with **Point 2** and **Point 3**. Point 2 should be in the centre and Point 3 at the lower or right side of the image.

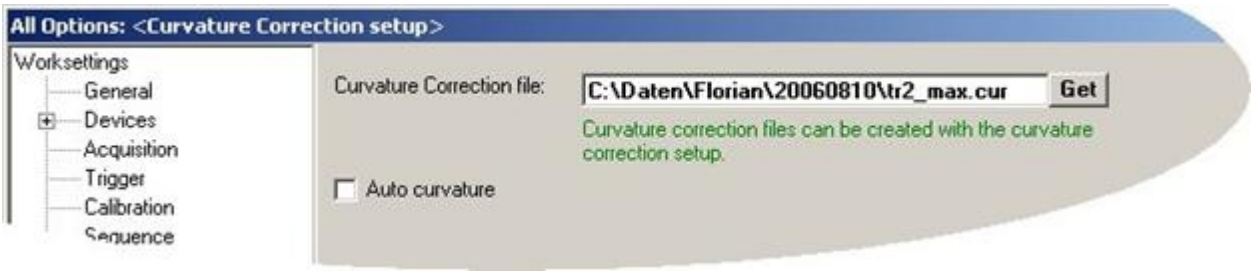
Click **Recall** in order to resume the previous data.

When **Draw Curve** is clicked a correction curve is calculated and displayed, which interpolates the three selected points. You can re-adjust some of the selected points if the curve does not yet fit correctly to your distortion. Click at the corresponding **Point** button, readjust the reference point and draw it again by pressing **Draw Curve**. If you are satisfied with the curve, click **Set.**

Save a correction set by clicking the **Save** button. Load a previously saved correction set by clicking the **Load** button and selecting the desired file.

Note: The purpose of this dialog is only to create files containing curvature correction data.

It does not activate any correction data
To activate a desired curvature correction data you have to specify the file with the correction data in the curvature correction setup:



To Apply the curvature correction according to the selected curvature data click to Curvature within the Corrections menu or select Curvature correction with the right mouse click to the image.

If you select Auto Curvature the image is automatically corrected after an acquisition has been finished.

Defect Pixel Correction

Corrections

Defect Pixel Correction

The defect pixel correction corrects defective pixels of a sensor by replacing their value with the average value of not defective neighbors.

In a first step (by using the defect pixel correction tool), bad pixels, lines or columns of the camera are detected. The co-ordinates of the bad pixels are then stored in a special data file.

During normal operation with the sensor the defective pixels are then corrected if the pixel correction function is enabled.

The intensity value of a defective pixel, line or column is calculated by the intensity values of the neighboring pixel.

Note: This chapter describes the defect pixel correction performed by the Software. Some cameras support a defect pixel correction inside the camera. To activate this defect pixel correction in the camera acquisition or options dialog.

Defect pixel correction tool

Corrections > Defect Pixel Correction

Defect pixel correction tool

The defect pixel correction tool is designed to generate coordinate data from image data showing defects. These coordinates are then used to correct images when they are acquired.

The procedure of getting coordinates of defects has to be done just once for a detector. In later sessions the stored pixel mask data will be used for correction.

Step 1

Acquire and store images with hot and/or dead pixel:

The recommended procedure is to acquire an image with a homogeneous illumination (only small grey level variation) at average pixel intensity of 50% of the maximum value. Whenever

possible it is recommended to acquire the image in Analog Integration mode with sufficient integration count. Use the camera binning mode settings and exposure time settings which you will typically use for routine operation.

Save the image on your hard disk.

This image will be further used to calculate dead pixel (which have significantly reduced sensitivity) and hot pixel (which have a high dark current).

If you will use the detector with several binning modes, you have to record one image of any binning mode.

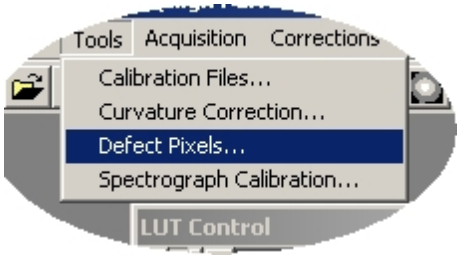
If you are planning to correct for hot pixel only, you may acquire an image without illuminating the detector (dark image).

You can also acquire a dark image and an image with illuminated detector and later use the dark image for hot pixel correction and the illuminated image for dead pixel correction.

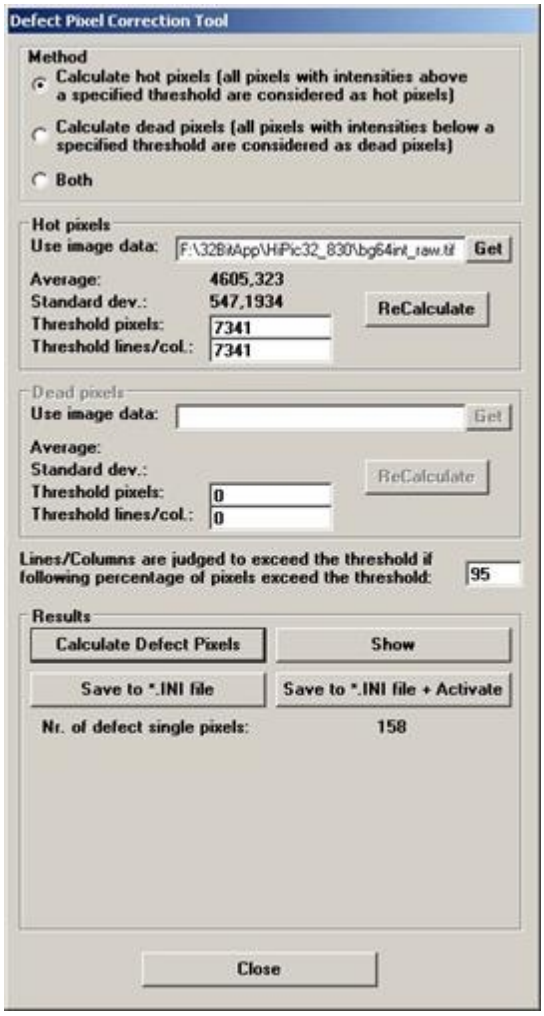
Step 2

Defect Pixel localizing tool

Select **Defect pixels** from the**Tools** menu to open the Defect pixel correction tool.



The Defect pixel correction tool will appear.



Step 3

At first you have to decide which method you want to apply. Select **Calculate hot pixels...** if you want to correct the pixels which have a higher dark signal than average pixel. Select **Calculate dead pixels...** if you want to correct the pixels which have a lower sensitivity than average pixel. Select **Both** if you want to correct hot and dead pixel (this is usually recommended).

Step 4

Select the defective pixel images in the defect pixel tool. If you have acquired different images for hot and dead pixel, please select the corresponding images in the sections.

Step 5

The system will suggest a reasonable threshold for discriminating normal pixel from bad pixel. The threshold is an intensity value which is related to the average intensity value and the standard deviation of the reference image. The value suggested by the software can be manually changed if the correction map is not reasonable upon customer s considerations.

Press **ReCalculate** in the Hot pixel and/or Dark pixel section to calculate the suggested threshold value again if it has been manually modified.

A separate value for singular pixel and lines/columns can be selected. These values may have to be chosen upon the features of individual sensors. If it turns out that the recommended values do not lead to satisfying results manual change is recommended. We can not give general recommendations for optimizing the threshold. User has to change and try.

An additional threshold is applied for lines/columns. Lines/columns are considered as defective

if the percentage of defective pixel in a line or raw exceeds the value defined in Threshold lines/Columns.

Usually a value greater than 80% leads to reasonable results.

Step 6

After completing the threshold settings you have to click **Calculate defective pixel**. Then the defective pixel mask will be calculated. You can see the number of defective pixels and lines/ columns indicated below the Calculate defective pixel button. The calculation will take a few seconds. As soon as finished is displayed the calculation has ended.

Step 6a

Optionally you can shot the defects by clicking to the **Show** command. They are displayed as overflow values in either the hot or dead pixel file (A new image is created, the old image is not overwritten).

Step 7

Finally you have to save the defective pixel mask in a specific file (*.ini file).

Press **Save to *.ini file** and then select file name and directory.

If you additionally want to activate this defect pixel information you can use the **Save to *.ini file + Activate** command.

Note: When you generate different pixel masks with different binning factors of the same detector you have to choose the same file for all pixel masks. The data are then all collected in one *.ini file. As the file already exists ins this case you get a warning message that this file already exists. Please ignore this message and continue saving the data to this file.

Enabling defect pixel correction

Corrections > Defect Pixel Correction

Enabling defect pixel correction

Specify the name of the defect pixel file in the defect pixel correction options and activate the checkbox Defect pixel correction:

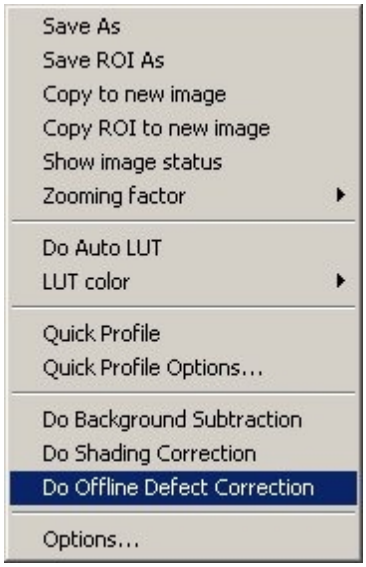
With every new acquisition the data is automatically corrected according to the information in the defect pixel file. If you select **Save to *.ini file + Activate** on the Defect pixel tool this is automatically done.

Offline Defect Pixel Correction

Corrections > Defect Pixel Correction

Offline Defect Pixel Correction

There is also an offline defect pixel correction available for images which have not been corrected during acquisition. This offline defect pixel correction can be executed with the context sensitive menu.



If you execute this command your will be asked which defect pixel map you want to use for this correction. The file selected in the Defect Pixel Options will be selected as the default.

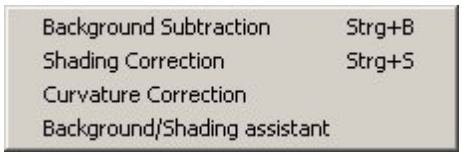
Background/Shading correction assistant

Corrections

Background/Shading correction assistant

To make the process of acquiring data and defining the settings for background correction or background and shading correction more easy and getting familiar with these corrections the background/shading correction assistant can be used. It guides you through the process of acquiring background/shading data and makes all necessary settings for you. It is strongly recommended for beginners to use the default/recommended settings initially. Once you got familiar and used to these settings you can easily use other more specific settings as well.

The Background shading correction assistant can be invoked with the Correction - Background/shading correction menu entry



A dialog will appear and asks you for several settings. We recommend to use the default/ recommended settings. We also recommend to start with background subtraction only first and once you are familiar with it use Background/ and Shading correct.

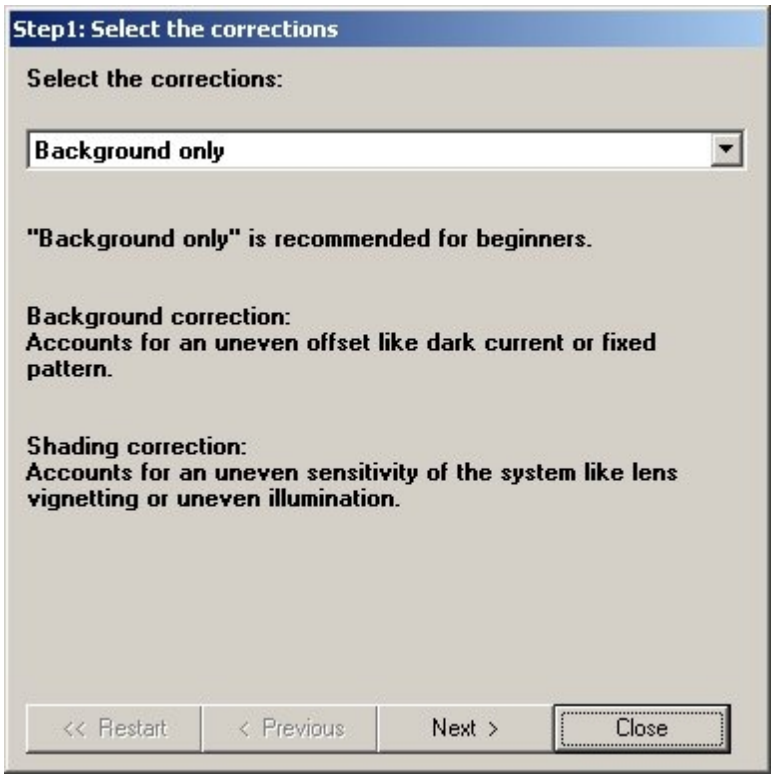
Performing Background subtraction

Corrections > Background/Shading correction assistant

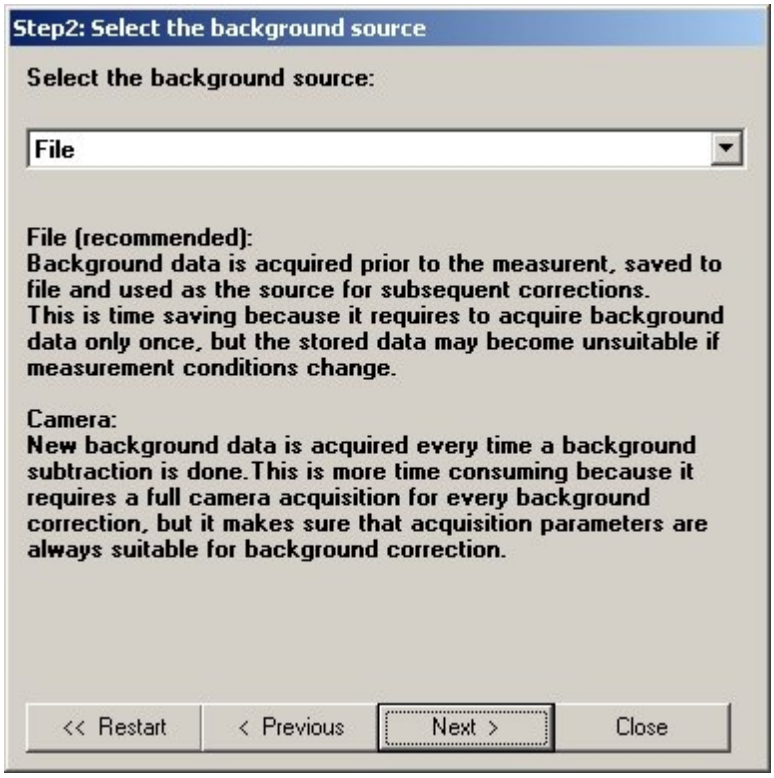
Performing Background subtraction

To perform background subtraction with the background/shading correction assistant invoke the background/shading correction assistant with the menu command Background/Shading assistant from the corrections menu.

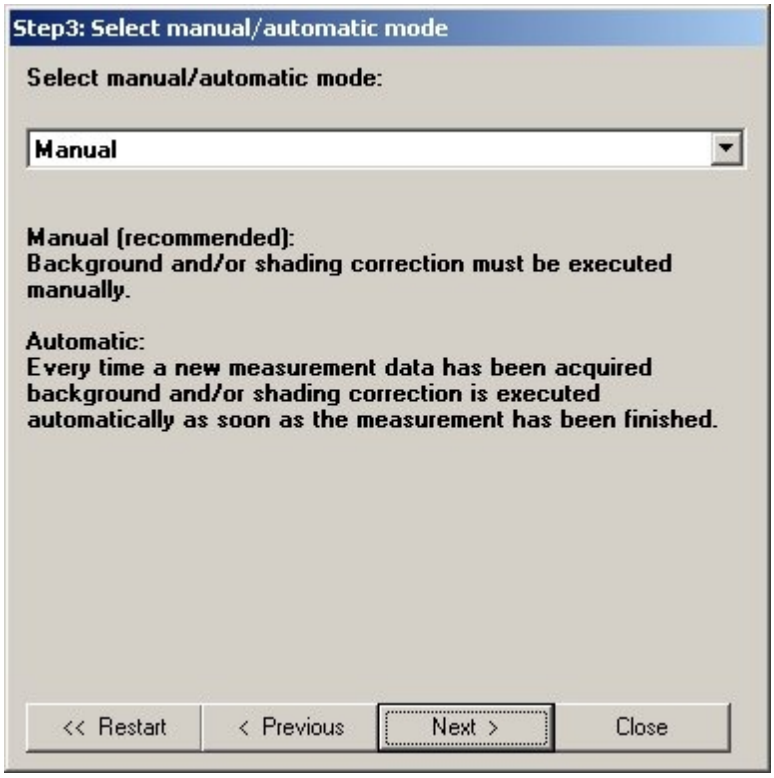
The following dialog will appear:



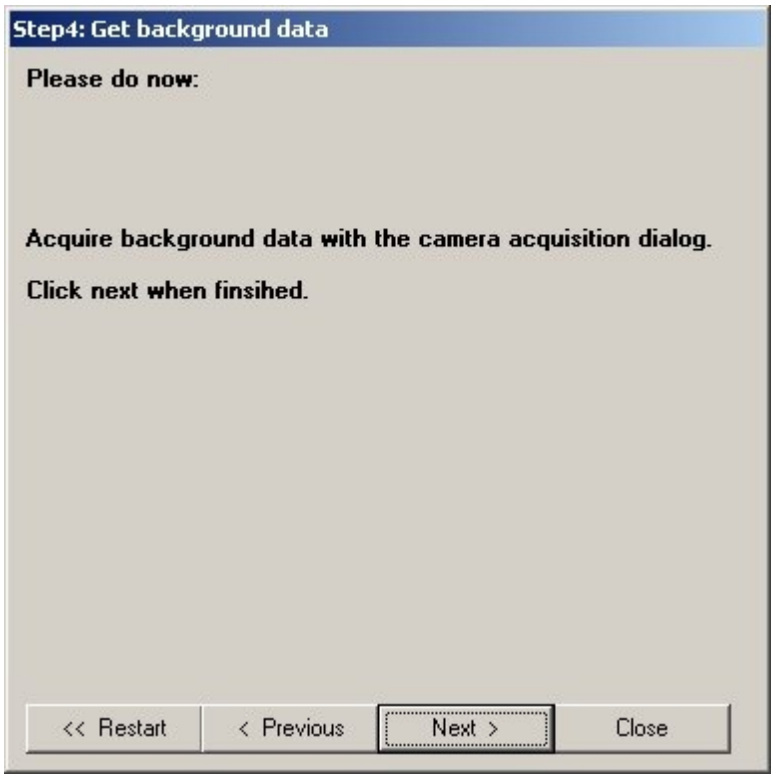
Select Background only (default) and click to Next. The next dialog will appear:



Select File (default) and click to Next. The next dialog will appear:



Select Manual (default) and click to Next. The next dialog will appear:

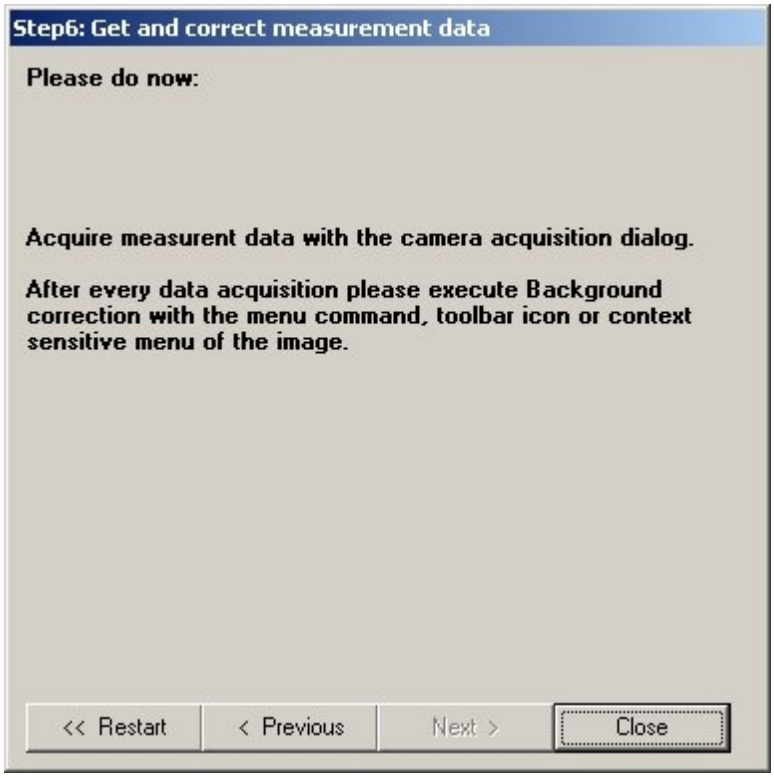


You should now acquire a background image which represents the background of your measurement. This image should be taken under the same conditions as the image you want to acquire for your measurement (i.e. binning, image size, analog gain settings etc.). Please use the camera acquisition dialog to acquire the image now. It is recommended to use the same acquisition mode as you want to use for your measurement (LIVE, ACQUIRE, ANALOGINTEGRATION).

Alternatively you could also use an image you have already saved to disk. Please load this image now or make it the current image (by clicking to it) if it has been loaded already.

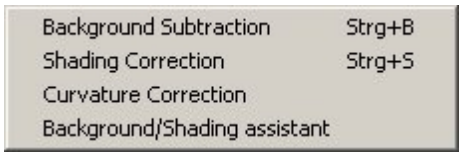
If this is finished, click to next. The software will save this image to a default file name and select this file in the background options automatically. You will get an informative message similar to the following:

After clicking to OK, you will get the next dialog:

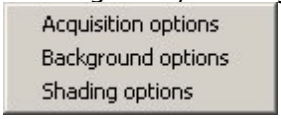


At this time you are finished with acquiring and setting up and you can acquire measurement data and correct them with the acquired background image.

To subtract background data from a given image you can use the Background subtraction menu item from the corrections menu



, the Background Toolbar Icon  , the context sensitive menu of the image which you want to correct (Click with the right mouse button to the image), the Real time background subtraction feature or the automatic background subtraction mode (this has to be selected from within the background options).

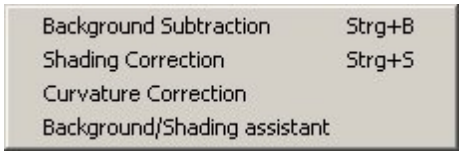
Clicking with the right mouse button to the background/shading assistant dialog will allow you to go directly to the background options. 

. These options contain more specific settings related to background subtraction.

Performing Background subtraction and Shading correction

We assume that you are familiar with acquiring background data with the Background/ Shading assistant. If not, please read the previous topic.

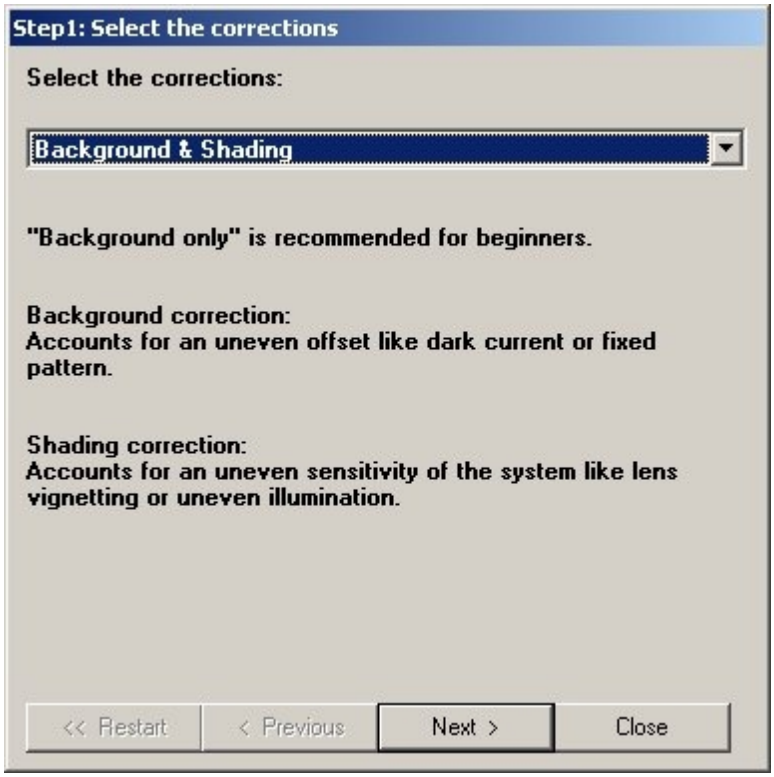
The Background shading correction assistant can be invoked with the Correction - Background/shading correction menu entry



A dialog will appear and asks you for several settings. We recommend to use the default/ recommended settings.

To perform background subtraction and shading with the background/shading correction assistant invoke the background/shading correction assistant with the menu command Background/Shading assistant from the corrections menu.

The following dialog will appear:



Select Background & Shading and click to Next.

Select File (default) and click to Next. The next dialog will appear:

Select Manual (default) and click to Next. The next dialog will appear:

You should now acquire a background image which represents the background of your measurement..

If this is finished, click to next. The software will save this image to a default file name and select this file in the background options automatically. You will get an informative message.

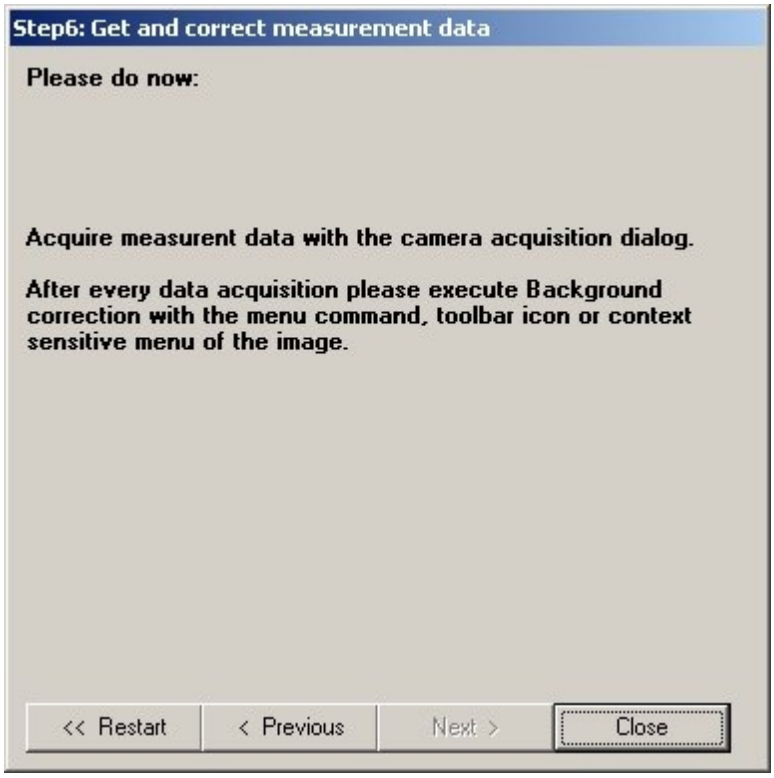
After clicking to OK, you will get the next dialog:

Acquire a shading image now. This shading image should represent the sensitivity variation of your system, which you want to account for. You can use any acquisition mode for this acquisition, but you should select a mode which outputs the full camera image (e.g Subarray mode is not suitable).

Alternatively you could also use an image you have already saved to disk. Please load this image now or make it the current image (by clicking to it) if it has been loaded already.

If this is finished, click to next. The software will save this image to a default file name and select this file in the shading options automatically. You will get an informative message similar to the following:

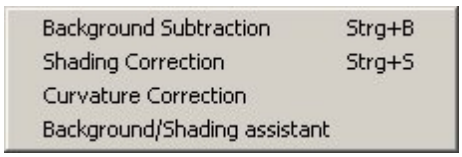
After clicking to OK, you will get the next dialog:



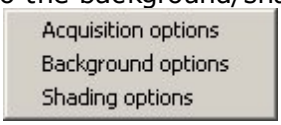
At this time you are finished with acquiring and setting up and you can acquire measurement data and correct them with the acquired background and Shading image.

Subtract background data as described in the previous topic.

To perform shading correction from a given image you can use the Shading correction menu item from the corrections menu



, the Background Toolbar Icon  , the context sensitive menu of the image which you want to correct (Click with the right mouse button to the image), the Real time Shading correction feature or the automatic Shading correction mode (this has to be selected from within the shading options)

Clicking with the right mouse button to the background/shading assistant dialog will allow you to go directly to the shading options. 

. These options contain more specific settings related to shading correction.

Reserved Filenames

Corrections > Background/Shading correction assistant

Reserved Filenames

As the Background/shading assistant saves and uses file to store background and Shading data there are several filenames you should not use by yourself. It is not recommended to replace or delete these files. The reserved file names are the following files within your application directory:

```
Reserved_BackgroundImage_General.img
Reserved_BackgroundImage_Live.img
Reserved_BackgroundImage_Acquire.img
Reserved_BackgroundImage_AnalogIntegration.img
Reserved_ShadingImage.img
```

Other Options

Corrections > Background/Shading correction assistant

Other Options

There are two more choices you can select if you run the background/Shading assistant.

In step 2 you can select Camera instead of File . In this case the background data is not saved to a file. Every time a background image is needed for a correction a new image is acquired from the camera. This setting does not influence the handling of shading data.

In step 3 you can select Automatic instead of Manual . In this case Automatic background subtraction and/or Automatic Shading correction is selected which means that after every acquisition immediately an background subtraction and/or Shading correction is performed. This options interferes with the real time background subtraction and the real time shading correction and should not be used if you intend to use the real time background subtraction and the real time shading correction.

There are several other options in the background and the shading options dialog. Please study these options if the standard behavior does not fit your needs.

Streak camera operation

Streak camera operation

This topic describes how the streak camera hardware is operated in combination with other peripheral devices.

Controlling Streak hardware

Streak camera operation

Controlling Streak hardware

This topic describes how to control streak camera and related hardware like spectrographs and delay generators.

Streak cameras / spectrographs / delay boxes

Streak camera operation > Controlling Streak hardware

Streak cameras / spectrographs / delay boxes

There are three different types of external hardware which can be operated by the program. Sometimes all these devices are called streak devices or external devices. These three device types are Streak cameras, spectrographs and delay generators (or simply called delay boxes). In total four devices can be configured by the system:

A Streak camera

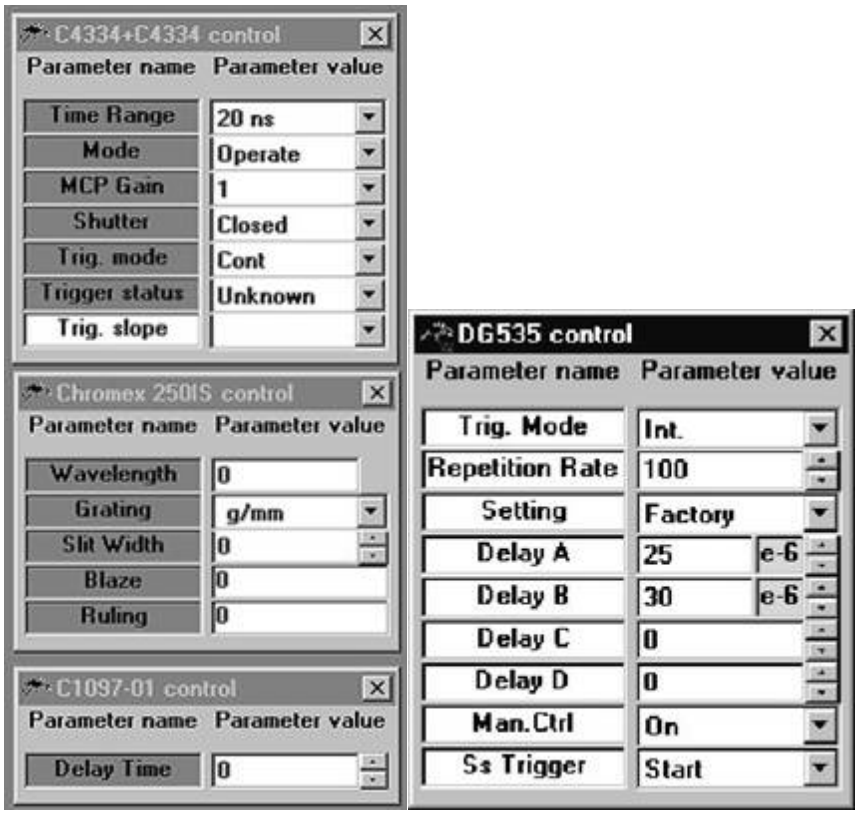
A spectrograph

Two delay generators

Status / Control dialog

Status / Control dialog

At program startup a status/control dialog will be created for each device which is used in the system. In this chapter common characteristics of such control boxes are described.



Device Status/control boxes (Streak camera C 4334, Spectrograph 250S, DG 535 and delay unit C 1097)

According to the information given in the set-up the system determines whether the device can be externally controlled, whether status information output is available, and which selectable parameters exist for this device and which values they can have.

If a parameter can be controlled by the HPD-TA, the background of the parameter name (left side of the status/control box) is green. If only status output is available, the background is light blue (in form versions this was red). If no control and no status are available the background is white, and if control but no status output is available the color is yellow.

Background color	Controlled via HPD-TA	Status indication	Description
Green	Yes	Yes	The parameter can be changed from the HPD-TA software, and the device status is indicated.
Light blue	No	Yes	The device status is indicated, but the parameter cannot be changed from the HPD-TA software.
Yellow	Yes	No	The parameter can be changed from the

(unusual)			HPD-TA software, but the device status cannot be indicated.
White	No	No	Neither the parameter can be controlled from the HPD-TA software nor is the device status indicated.

Color coding of Status/Control boxes

Note: Even in cases where the parameter and device status cannot be controlled from the HPD-TA it can be advisable to enter the correct values reflecting the real status of the device. This is due to the fact that the HPD-TA software will activate certain actions (e.g. selecting a corresponding scaling file) depending on this device status. Additionally, the value of the parameter field is written to the Image Status and is saved with the image.

Device control box (example)

1) Parameter name field

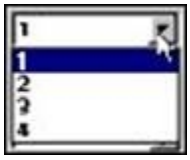
2) Combo box

3) Edit field

4) Spin control

There are different types of parameters and the corresponding controls are different:

Combo box



Click on the arrow button on the right side of the parameter value field (example: Time Range). Select the desired value from the combo list by using the mouse, cursor keys or keyboard.

Press the Home or End key to go to the first or last value in the combo list, respectively.

Press the PgUp or PgDown key to scroll one page in the combo list.

Spin control

Click on the appropriate button of the spin control to select the desired parameter value.

With the help of modifier keys (Shift, Ctrl, Alt) the step size can be increased as follows:

Mark the desired parameter value with the mouse.

Step size 1: press cursor key (up, down)

Step size 10: keep one modifier key pressed and press cursor key (up, down)

Step size 100: keep two modifier keys pressed and press cursor key (up, down)

Step size 1000: keep three modifier keys pressed and press cursor key (up, down)

Edit field

To change parameter values in an edit field (example: Gate Time) mark the parameter value with the mouse and input the desired value with the keyboard. Press the Tab key to activate the new value.

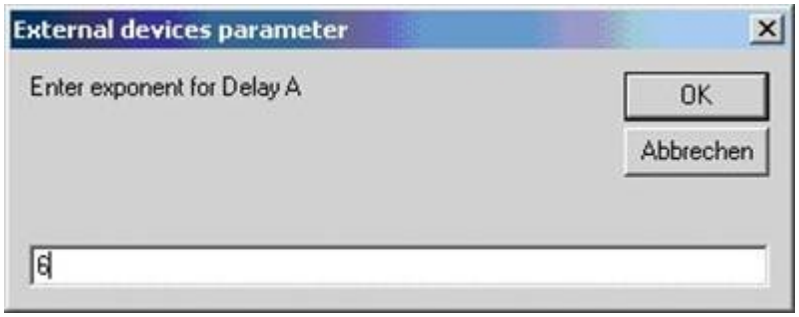
Parameters may be displayed in exponential form a x 10y. a is then displayed on the left side of the parameter field and the exponent y is displayed on the right side.

To change the exponent of the parameter proceed as follows:

1) Select the parameter where you want to change the exponent (In this case there is no exponent at all).

2) Place the cursor inside the textbox

3) Type the letter e . The following dialog will appear:



4) Enter the new exponent and press enter or click to OK. The parameter value will be displayed with the exponent.

Now the spin up/down buttons are used to change the value of the mantissa only.

If only status output is available for a parameter (if the user cannot modify this parameter) then its value is displayed in a display box, and there will be no control element for it.

In this case, the parameter must be changed at the device manually, and the HPD-TA will sense the change through the status input and reflect it correctly in the display box.

Switching from focus to operate mode within the streak cameras status/control box activates the streak trigger checkbox in the image acquisition menu and activates the synchronization. Switching from operate to focus mode deactivates the streak trigger checkbox.

If no control and no status output is available, you will need to control the device manually but the HPD-TA cannot sense any status changes automatically. In this case, you should change the parameter in the Status/Control box explicit and manually as well, so that the programs internal status reflects the status of the device correctly. This is very important for the correct handling of image status information, scaling data, and so forth.

In case a distinct step width between allowable parameter values is known to the system (integer type parameters and special real type parameters) one can use the arrow up and arrow down cursor keys to increase and decrease the value as well as the spin control. If you additionally press Shift, Control or Alt key the step width depends of the number of such keys. If a single key is pressed (either Shift, Control or Alt) the step width is increased 10 times. If two such keys are pressed (either Shift and Control or Shift and Alt or Control and Alt) the step with is increased 100 times. If all three keys are press (Shift, Control and Alt) the step with is increased 1000 times. This is true both for the spin control and the arrow keys.

Emergency!

Streak camera operation > Controlling Streak hardware

Emergency!

Emergency! is a function to protect your streak camera from any damage if too much light enters the camera by some accident.

Select **Emergency!** in the File menu or press the function key F8, to set the MCP gain of your streak camera to the minimum value and to close the streak camera shutter and/or the shutter of the spectrograph immediately.

Of course this can only work if the respective devices can be controlled by GPIB.

Safety functions by software

Streak camera operation > Controlling Streak hardware

Safety functions by software

Since version 9.1 software driven safety functions have been implemented which prevent the MCP to be exposed unintentionally by strong light when switching parameters like Mode, Gating, time ranges, grating or the like. These functions are independently of the current streak camera model and follow strict and well understandable rules.

Please be aware that these functions are executed form software only and may fail under certain conditions. Also be aware that there are many operation conditions which may lead to an overexposure or damage of photocathode or MCP which cannot be recognized by software. Always keep in mind that you as an operator of the software remain responsible for the save operation of the system.

Status Inquiry

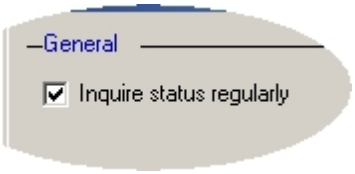
Streak camera operation > Controlling Streak hardware

Status Inquiry

Normally streak devices which are connected by GP-IB, RS232 or USB are inquired regular by

this interface. In some circumstances this inquiry is undesired. Therefore there is an option in the streak options which allows switching this feature on or off.

Note: If this feature is switched off changes in the devices caused by external reasons as the focus timeover are not recognized by the software any more. Even though this options is placed in the streak options it is also valid for spectrographs and delay boxes.



Auto functions

Streak camera operation > Controlling Streak hardware

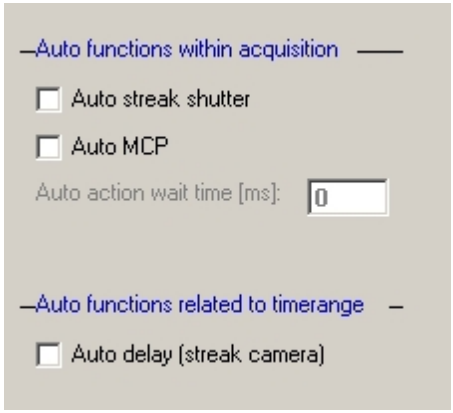
Auto functions

There are several automatic functions which can be activated in the corresponding options dialog. Most of these relate to actions during acquisition. The behavior of these functions can be controlled by the respective options dialogs

Auto options for Streak cameras

Streak camera operation > Controlling Streak hardware > Auto functions

Auto options for Streak cameras



There are three auto functions in conjunction with streak cameras:

If **Auto streak shutter** is selected the streak shutter will be always automatically opened when an acquisition is started and automatically closed when the acquisition ends. This feature can be used to prevent the streak camera of being exposed to incident light when no measurement is under progress. We strongly suggest to use this feature, if applicable, to help avoiding accidental damage or tube burn-in.

If **Auto MCP** is selected the MCP gain as previously set by the user will automatically be set when an acquisition is started and automatically set to the minimum value when the acquisition ends. This is also a function which helps to protect the streak tube when no measurement is under process.

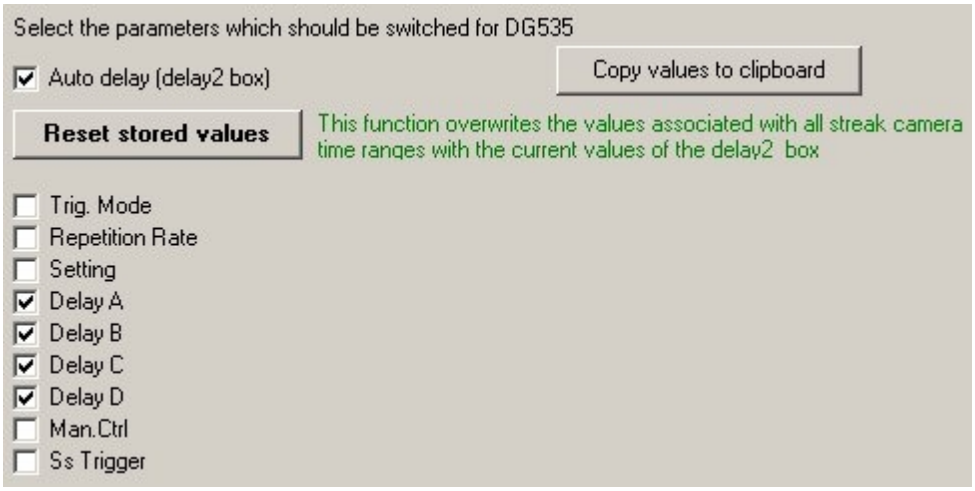
If **Auto delay (streak camera)** is selected, the delay parameter in the streak camera s control box will be saved when you change the time range and restored when the time range is used the next time.

Auto options for delay boxes

Streak camera operation > Controlling Streak hardware > Auto functions

Auto options for delay boxes

There are two individual options dialogs for the delay generator and delay2 generator which behave identical.



If **Auto delay (delay box)** is selected, the current settings of a delay unit will be automatically saved when you change the streak camera time range. These parameters will be set again, when you return to this time range later.

Select the parameters which shall be saved and restored. Press **OK** to save the setting. Press **Restore stored values** to reset all stored values to the currently selected values.

If **Copy Values to Clipbord** is executed the AutoDelay values associated to the different time ranges are copied to the clipboard. From there they can be imported in Microsoft Excel or similar programs.

After inputting the values into Microsoft Excel the spreadsheet may look like this:

	A	B	C	D	E
1	C5680/M5677 + DG535				
2	Timerange	Delay A	Delay B	Delay C	Delay D
3	5 ns	0.001	0.002	0.00011	0.00054
4	10 ns	0.0012	0.002	0.000122	0.00052
5	20 ns	0.0013	0.002	0.00011	0.00054
6	50 ns	0.0014	0.002	0.0001222	0.000511
7	100 ns	0.001	0.002	0.00013	0.00051
8	200 ns	0.001	0.002	0.0001	0.00052
9	500 ns	0.001	0.002	0.0001	0.00053
10	1 us	0.00155	0.002	0.0001	0.00054
11	2 us	0.00133	0.002	0.0001	0.00055
12	5 us	0.00122	0.002	0.0001	0.00051
13	10 us	0.00111	0.002	0.0001	0.000555
14	20 us	0.00155	0.0021	0.0001	0.000566
15	50 us	0.001	0.0022	0.0001	0.000534
16	100 us	0.001	0.0023	0.0001	0.00052
17	200 us	0.00144	0.0024	0.0001	0.00053
18	500 us	0.00153	0.0025	0.0001	0.00052
19	1 ms	0.001444	0.0026	0.0001	0.00052

This data can now easily be stored and kept at a save place for backup and documentation.

List of all streak camera parameters

List of all streak camera parameters

The following is a list of all streak camera parameters, their range and an explanation of its meaning.

Parameter	Range	Description
Time range	Any time in physical units (like 0.3 ms) -or - 1,2,3,4 for synchroscan	Sweep speed of vertical streak sweep. Normally the time to perform a full sweep is indicated. The sweep direction normally is vertical for this parameter. The selected time range is only active in Operate mode.
Mode	Focus / Operate / Finder	Operation mode of the streak camera. Focus: In Focus mode the photoelectrons are not deflected. This mode is used to focus the streak camera optics and to align the input light. See also Shutter and Focus Time Over. **Warning: Danger of tube damage. Don t work with high input light power in Focus mode.** Operate: In Operate mode the photoelectrons are deflected. The applied deflection voltage depends on the selected time range (see Time Range). Measurements are done only in Operate mode. The sweep direction normally is vertical for this parameter.
Gate Mode	Normal / Post Blanking / gate A / Gate B - or - Normal / Ext	Some streak cameras have to possibility to apply a gate signal to either photocathode, MCP or both. Gate Mode specifies the method of gating. See the streak camera hardware manual for details and timing diagrams.
MCP Gain	Integer number [arbitrary]	Controls the high voltage applied to a multi channel plate (MCP) inside the streak tube mounted close to the phosphor screen. When the MCP gain is set to 0, the MCP still operates at a non-zero minimum voltage.
Shutter	Open/Closed	Controls the status of a mechanical shutter in front of the photocathode of the streak camera. If the streak camera has a focus time over parameter: In Focus mode the shutter is automatically closed after the time indicated in the field Focus Time Over has run out.
Blanking Amp.	Any time in physical units (like 0.3 ms), Off -or - 1, 2, Off	Depending on the configuration the streak camera can also have a deflection in horizontal direction. This deflection is done either by a synchronous blanking unit (sweep synchronized to the vertical sweep) or by a dual time base extender (independent triggered sweep). Same as time range indicates the deflection for the vertical sweep Blanking Amp. defines the sweep speed for the horizontal sweep. Off means no horizontal sweep. The deflection can either be

		single shot or synchronous. Synchronous blanking is used to guide the return sweep outside the phosphor screen. A dual time base extender is used to image several vertical sweeps on the same image.
Gate Time	Any time in physical units	Time use to define the gate operation. See the streak camera hardware manual for details.
Trig. Mode	Cont/Single	This parameter defines the reset behavior for a vertical single shot sweep. Cont (Continuous) means that an automatic reset occurs after each sweep. Single means that the reset has to be done explicitly either by a switch, TTL pulse or GPIB. Depending on the settings in the trigger options of the HPD-TA this parameter may be switched automatically to the correct value for the operation mode.
Trigger Status	Ready / Fired / Do Reset	Selection and indication of the vertical trigger status. Ready: Ready is displayed when the system is ready to receive a trigger signal. Fired: Fired is displayed when the system has received a trigger signal but the sweep has not been completed or no reset signal has been applied until now. The system will ignore trigger signals during this state. Do Reset: Do Reset can be selected when the system is in trigger mode Fired. After selecting Do Reset the trigger status changes to Ready.
Trig. Level	Integer number [Volt]	Input and indication of the trigger level for the vertical sweep.
Trig. Slope	Rising / Falling	Selection and indication of the trigger slope of the vertical sweep
H. Trig. Status		Selection and indication of the horizontal trigger status. Ready: Ready is displayed when the system is ready to receive a trigger signal. Fired: Fired is displayed when the system has received a trigger signal but the sweep has not been completed or no reset signal has been applied until now. The system will ignore trigger signals during this state. Do Reset: Do Reset can be selected when the system is in trigger mode Fired. After selecting Do Reset the trigger status changes to Ready.
H. Trig. Mode		This parameter defines the reset behavior for a horizontal single shot sweep. Cont (Continuous) means that an automatic reset occurs after each sweep. Single means that the reset has to be done explicitly either by a switch, TTL pulse or GPIB. Depending on the settings in the trigger options this

		parameter may be switched automatically to the correct value for the operation mode.
H. Trig. Level	Integer number [Volt]	Input and indication of the trigger level for the horizontal sweep.
H. Trig. Slope	Rising / Falling	Selection and indication of the trigger slope of the vertical sweep
Delay	Integer number [arbitrary]	Selection and indication of the delay time set by the delay generator within the streak camera. (Phase shift applied to vertical synchroscan deflection).
Focus TimeOver	Integer [Minutes]	Selection and indication of the time after which the shutter is closed if the streak camera is in Focus mode.
Phase	Integer number [Arbitrary]	Selection and indication of the phase difference between the vertical and horizontal deflection (turn angle of deflection ellipse). This parameter refers to synchroscan only.
PLL Mode	Locked / Unlocked	Defines the operation mode of the built in PLL. See the hardware manual for details.
PLL Status	Initial / Scanning / Locked / Error 0 / Error 1	Defines the status of the built in PLL. See the hardware manual for details.
Inp. Power	High / Low	Input level of the trigger input. See the hardware manual for details.
H. Trig Input	Int /Ext	Defines the trigger input for the horizontal sweep. See the hardware manual for details.
II Gain	Integer number [arbitrary]	Selects the voltage of an externally connected Image intensifier

Synchronization and synchronization options

Streak camera operation

Synchronization and synchronization options

Synchronization is a way to synchronize the streak camera with the CCD camera. In previous version of this software this was called streak trigger . Besides streak camera, CCD camera and computer several additional components can contribute to this interaction like a counter/ timer board, a GP-IB board, BNC and other cable connections, a dedicated programming of camera parameters and special algorithms of the software itself.

General

Streak camera operation > Synchronization and synchronization options

General

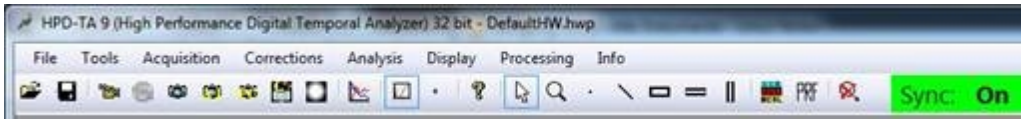
Most of the settings which define the methods and parameters of synchronization are defined in the synchronization (trigger) options dialog.

Warning: The interaction can be rather complex and only if all components are working together properly the desired result will be reached. Basically these settings have been done during installation by an experienced Hamamatsu engineer, so there is no need to change any of these settings. If you are not sure which parameters should be set to which values please do not change any parameters unless you know the precise meaning of these parameters.

Activating synchronization

Activating synchronization

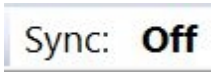
Once all settings are done, the synchronization can be activated easily from the main HPD-TA window by clicking on the Sync pushbutton.



If the system is synchronizing the color of this pushbutton is green:

If the system is ready for synchronization the color of this pushbutton is yellow:

If the system is not ready for synchronization the color of this pushbutton is white and can have both values On and Off:



Synchronization methods

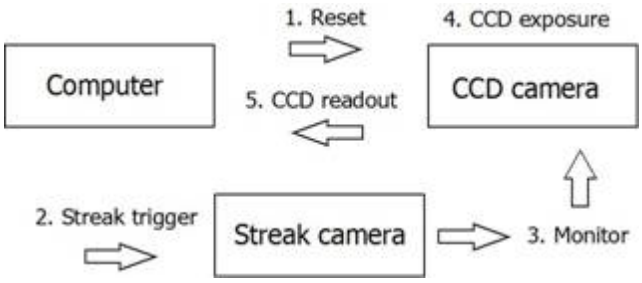
Synchronization methods

Basically HPD-TA offers three different types of synchronization methods:

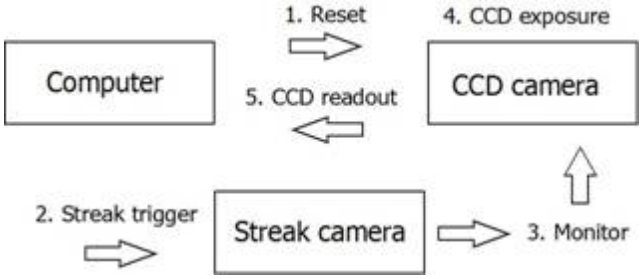
Sequential trigger

Sequential trigger

Streak trigger and CCD camera exposure is done one after the other. The monitor out signal of the streak camera triggers the start of the exposure. The exposure time is defined by the user and fixed for all trigger events. This method is called sequential method because streak triggering and CCD exposure is done sequentially.



Block diagram of sequential trigger



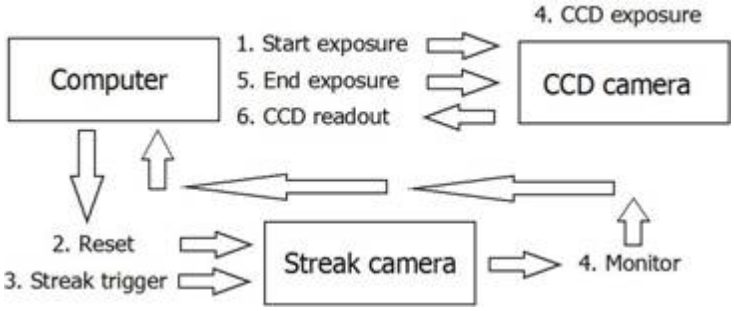
Timing diagram of sequential trigger

Enclosing trigger

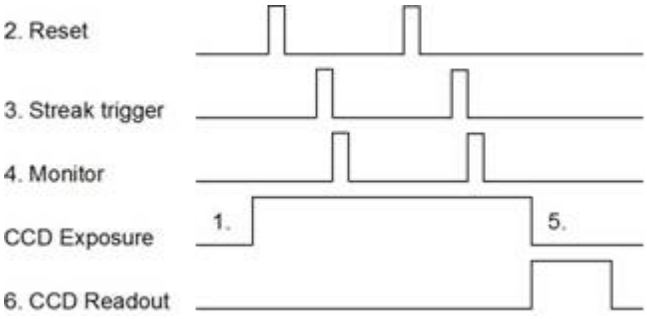
Streak camera operation > Synchronization and synchronization options > Synchronization methods

Enclosing trigger

The CCD camera is started and stopped by computer control. After start of an exposure the trigger handshake starts. When all triggers have been processed the CCD camera exposure is ended by computer control and the resulting image is read out. This method is called Enclosing method since all actions related to streak synchronization happen during the exposure time of the CCD camera.



Block diagram of enclosing trigger



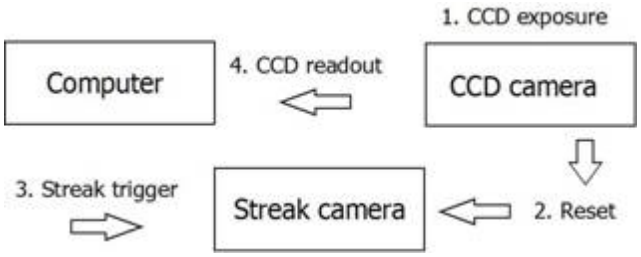
Timing diagram of enclosing trigger

CCD master

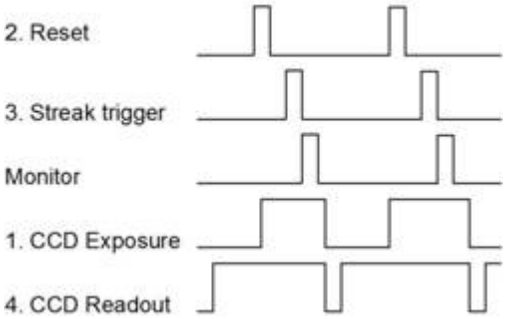
Streak camera operation > Synchronization and synchronization options > Synchronization methods

CCD master

The CCD camera operates in internal mode, thus defining the frequency. An output from the CCD camera resets the streak camera, which will be triggered by the next trigger from the experiment.



Block diagram of CCD master



Timing diagram of CCD master

Setting up synchronization

Streak camera operation > Synchronization and synchronization options

Setting up synchronization

This chapter describes how to set up the synchronization.

General

Streak camera operation > Synchronization and synchronization options > Setting up synchronization

General

To properly use one of the synchronization method all necessary settings have to be done in the synchronization options dialog.

The dialog will change according to the selection you have made.

The Synchronization options dialog shows the required connections blinking in red. Once the user has established the connection he should confirm these in a checkbox located nearby the blinking line. When all necessary connections are done properly and confirmed the Synchronization options dialog shows Configuration valid with green background. (Sometimes there are optional connections which can be done to speed up operation. These are indicated with blinking white connection lines.)

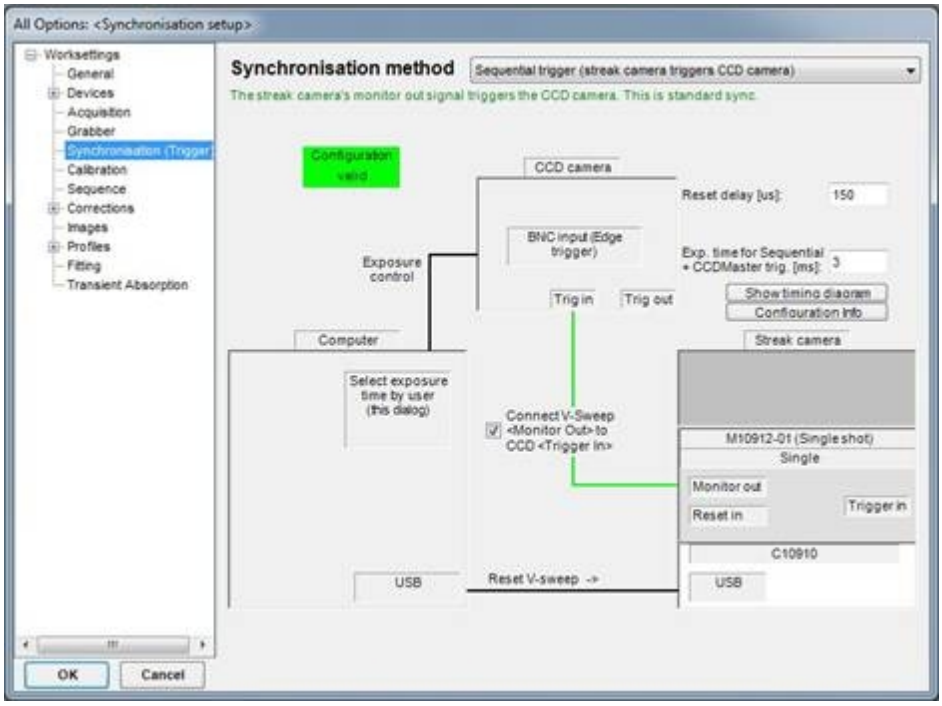
The user has to make the necessary settings in the streak camera control window if the streak camera is not connected by GPIB or USB. In the case the streak camera is connected by GPIB or USB the necessary settings are set when the Synchronization options dialog is quit by the OK pushbutton (of course they can be changed afterwards, so be careful not to change any parameters which are essential to the trigger operation) or when the user switches between Operate or Focus mode or time ranges of the Blanking amp. Parameter (which defines the horizontal sweep of a dual time base extender).

Setting up sequential trigger

Streak camera operation > Synchronization and synchronization options > Setting up synchronization

Setting up sequential trigger

The following is the options dialog for the sequential trigger setup:



The following settings have to be done:

- Confirm the connection between monitor out of the streak camera and the trigger in of the CCD camera.
- Set the reset delay.
  The value entered for the **Reset delay (µs)** specifies the delay between the "monitor out" and the "reset in" pulses in microseconds when working with external triggers. The default setting of 1500 microseconds should work for all Hamamatsu streak cameras. The value can be decreased in some cases in order to achieve higher repetition rates (contact Hamamatsu for details on specific streak cameras). The minimum value is 1.
- Set the exposure time.
  This exposure time will be automatically set when synchronization is activated.

Please take care of the following issues when using this mode:

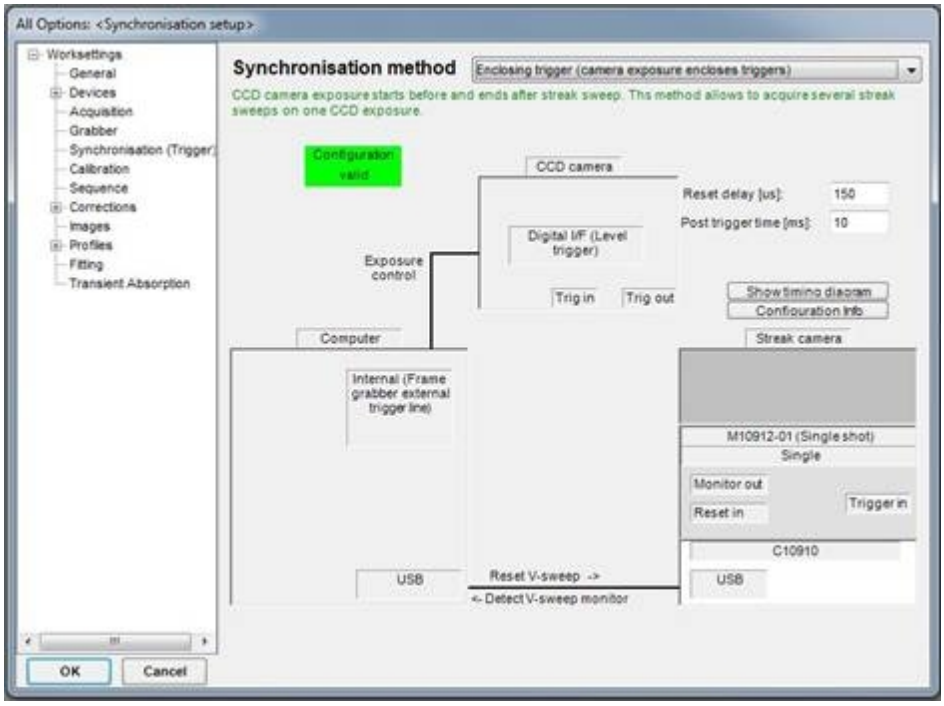
- The monitor out signal of the streak camera must be before the sweep.
- Exposure time must be defined correctly. Monitor out must be sufficiently long time before sweep (depends on CCD camera reaction time).
- If the pulse characteristics of the monitor out pulse from the streak camera does not match the requirement for the trigger input of the CCD camera this method may not work.

Setting up enclosing trigger

Streak camera operation > Synchronization and synchronization options > Setting up synchronization

Setting up enclosing trigger

The following is the options dialog for the enclosing trigger setup:



The following settings have to be done:

- Set the reset delay.
  The value entered for the **Reset delay (µs)** specifies the delay between the "monitor out" and the "reset in" pulses in microseconds when working with external triggers. The default setting of 1500 microseconds should work for all Hamamatsu streak cameras. The value can be decreased in some cases in order to achieve higher repetition rates (contact Hamamatsu for details on specific streak cameras). The minimum value is 1.
- Set the post trigger time.
  The value entered for **Post trig. time (ms)** specifies the time, for which the acquisition still continues after the specified number of triggers are counted. This is useful for very long time ranges or if some afterglow of the streak cameras phosphor screen has to be integrated.

Please take care of the following issues when using this mode:

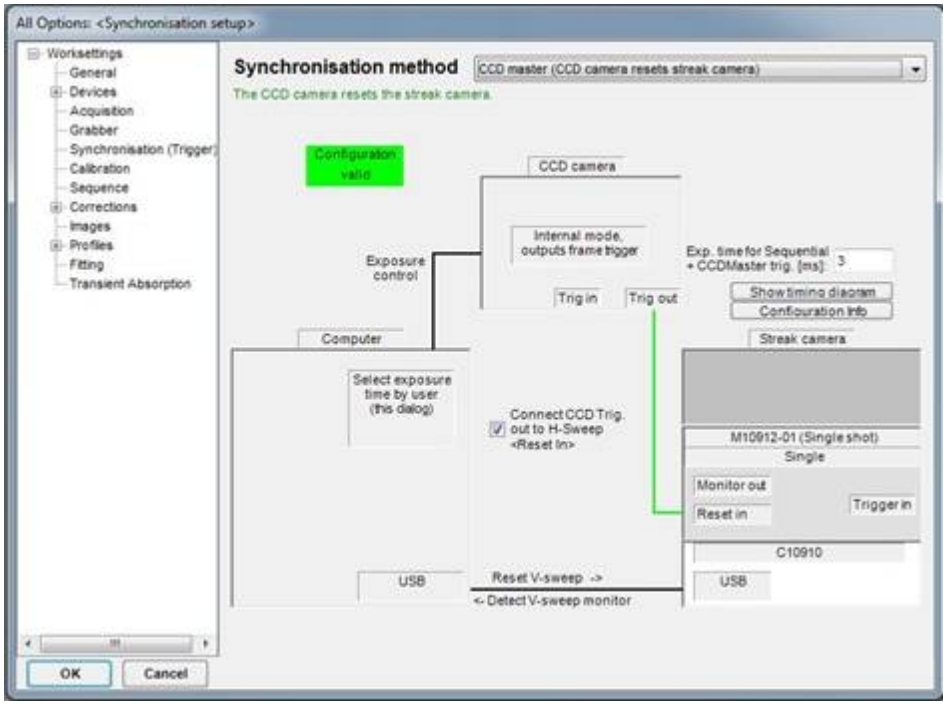
- Dark current varies with exposure time. (If repetition rate is very low and non-constant, this may be a problem)

Setting up CCD master

Streak camera operation > Synchronization and synchronization options > Setting up synchronization

Setting up CCD master

The following is the options dialog for the CCD master setup:



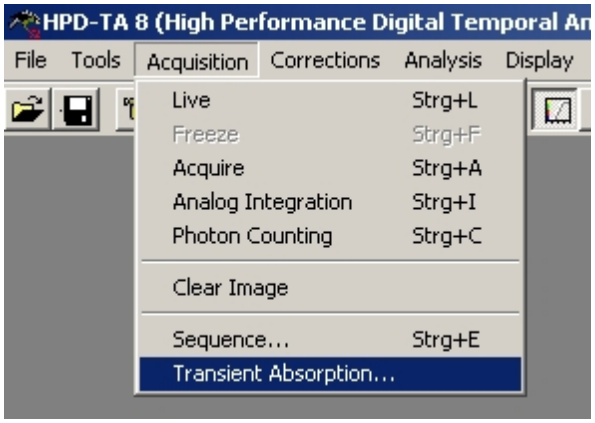
The following settings have to be done:

- Confirm the connection between the trigger out of the CCD camera and the resest in of the streak camera.
- Set the reset delay.
  The value entered for the **Reset delay (µs)** specifies the delay between the "monitor out" and the "reset in" pulses in microseconds when working with external triggers. The default setting of 1500 microseconds should work for all Hamamatsu streak cameras. The value can be decreased in some cases in order to achieve higher repetition rates (contact Hamamatsu for details on specific streak cameras). The minimum value is 1.
- Set the exposure time.
  This exposure time will be automatically set when synchronization is activated.

Transient Absorption measurement

Transient Absorption measurement

The transient absorption measurement system is an option of the HPD-TA. It is only available if the hardware lock contains a key to unlock this option. To start a transient absorption measurement execute the Transient Absorption Menu command.



If this command is not available, your hardware lock may not contain the license for the option.

Please see the Transient Absorption measurement manual for details of the operation.

Photon correlation measurements

Photon correlation measurements

This chapter describes how to perform photons correlation measurements.

Introduction

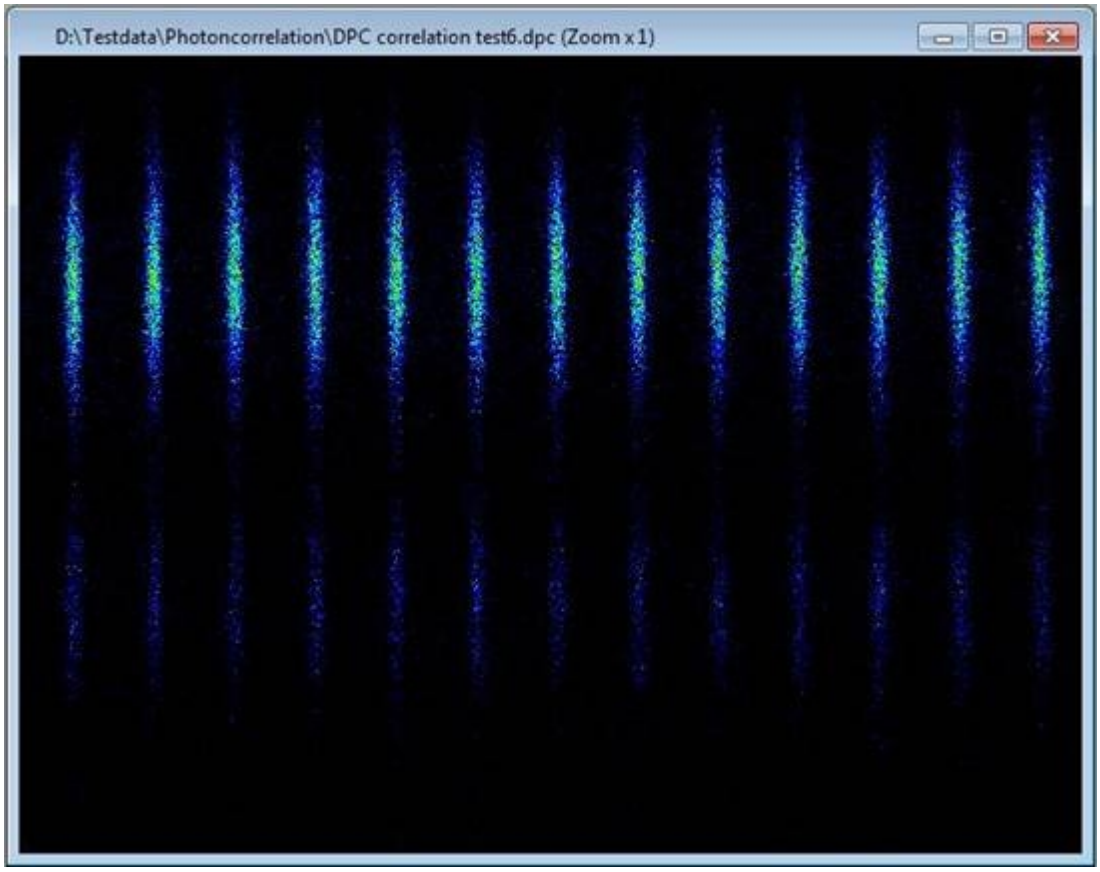
Photon correlation measurements

Introduction

Note: Photon correlation measurement is an option to the HPD-TA and requires a key on the hardware lock.

Photon correlation measurements are based on a specific streak camera hardware including a special dual time base extender, a pinhole input, a fast readout camera and a synchronization mechanism allowing high frame rate.

In principle the whole system is operated in photon counting mode recording the location of the photons for every frame. The dual time base extender is setup in a way so that the electrons created by photons of the pinhole are swept in vertical direction while the dual base extender deflects the electrons in the horizontal direction. A series of photon traces is thus generated for every frame (see the following screenshot):

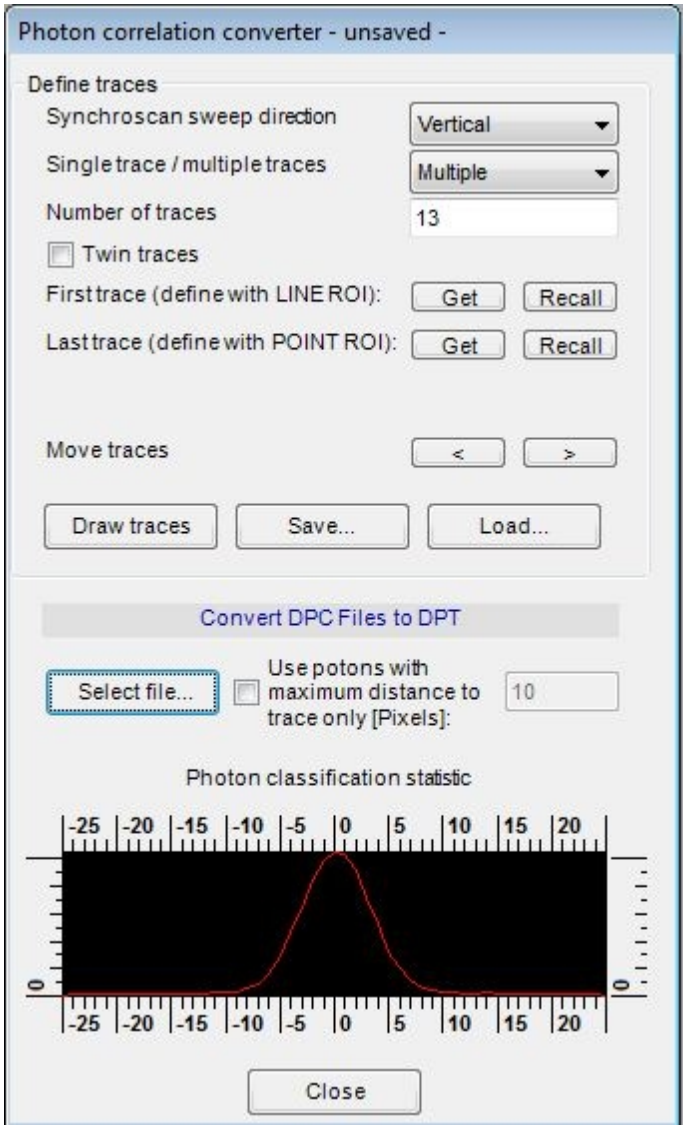


Setting up photon traces

Photon correlation measurements

Setting up photon traces

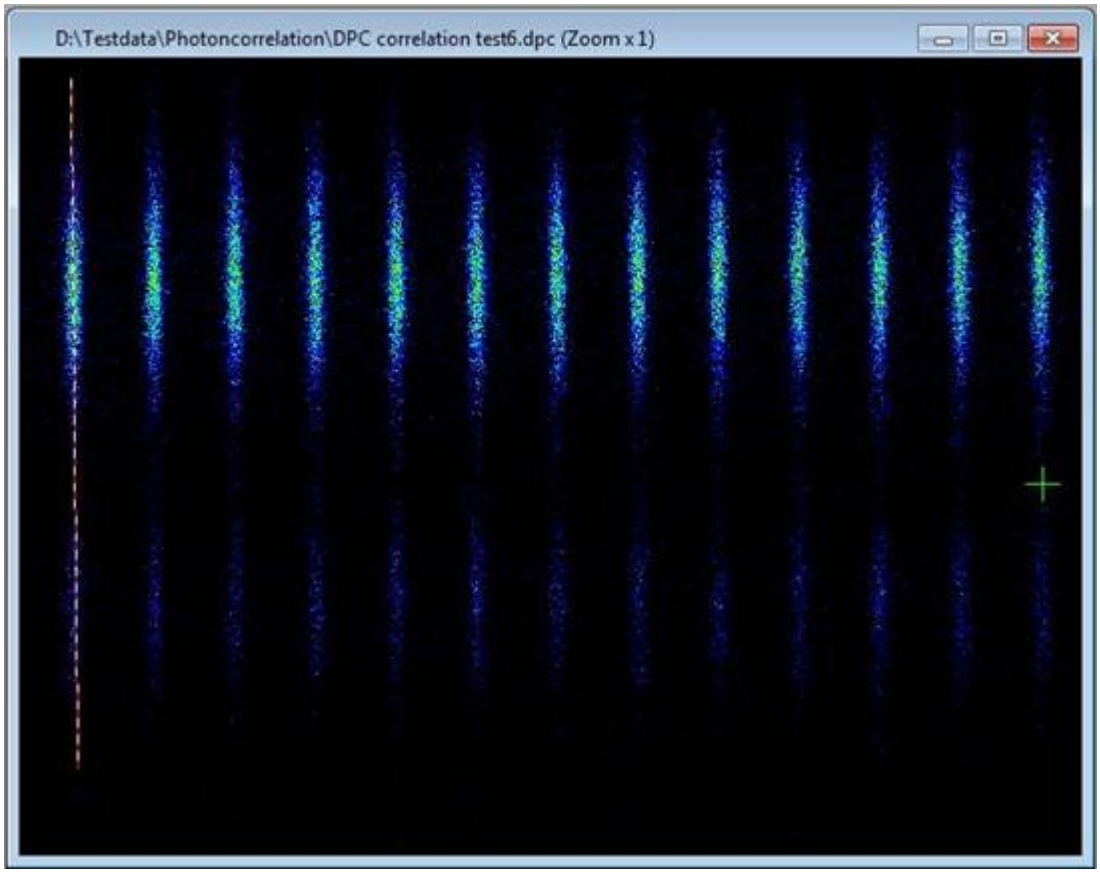
To calculate the correlations between individual photons it is crucial to identify the trace number for every photon. Do be able to do so we have to tell the system the number and location of the photon traces. This is done by the Photon correlation converted dialog. Execute the Tools Photon Correlation Converter menu command to show the Photon correlation converted dialog.



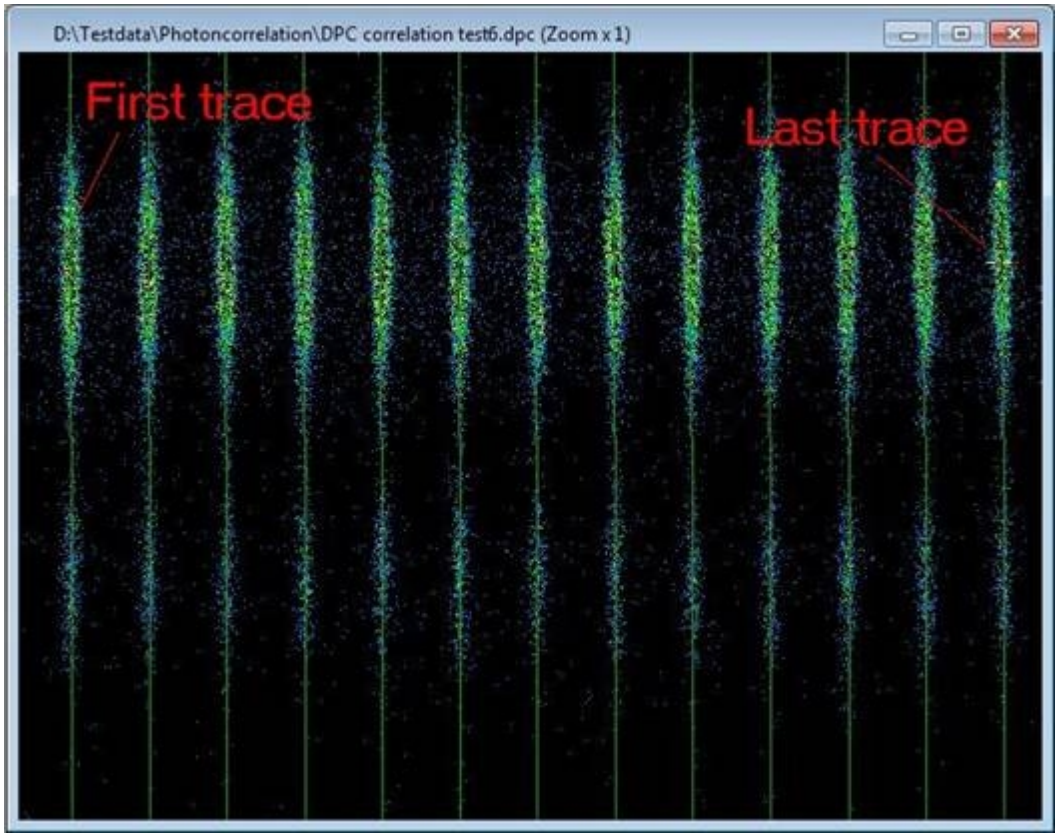
To identify the photon traces we have to select:

- The Sweep direction of the synchroscan sweep
- The number of traces
- The location of the first trace. This has to be done with a line ROI which covers the trace. This line does not need to be completely vertical, but is normally almost vertical. Define the Line ROI and Push Get right of the label First trace . If you have already defined a first trace, pressing Recall puts the line ROI on screen.
- The location of the last trace. This has to be done with a point ROI which lies in the center of the last trace. Define the Point ROI and Push Get right of the label Last trace . All other traces are equidistant between the first and last trace and have the same slope as the first trace. If you have already defined a last trace, pressing Recall puts the point ROI on screen.

All traces are now drawn on the current image. If there was no image initially or if you have switched to another image you can redraw the traces by clicking to Draw traces . Using Recall and Get you can fine adjust the locations of the first and the last traces to cover completely the traces. With the pushbuttons labeled with a left or right arrow you can move the whole set of traces by one pixel. The whole setup can be saved and loaded to disk by using the Save and Load pushbuttons.



Setting up photon traces by drawing a line ROI (left) and a point ROI (right)



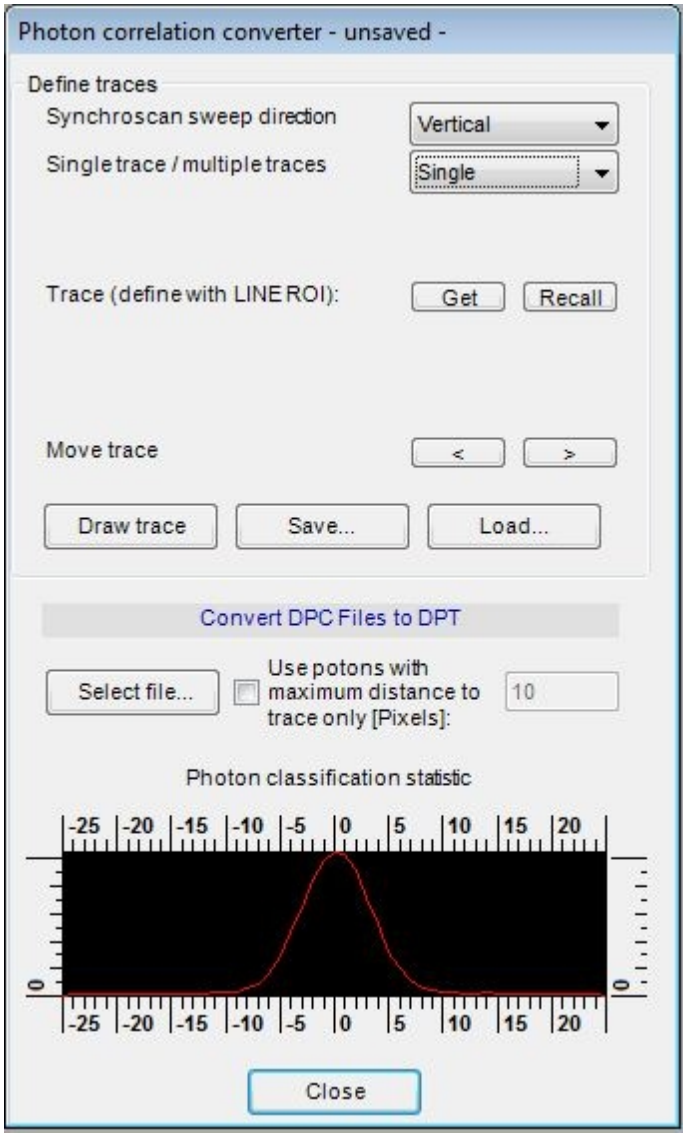
Traces drawn by the photon correlation converter

Single trace mode

Photon correlation measurements

Single trace mode

Sometimes no dual time base extender is used for this measurement, resulting in the fact that there is only one trace. As the mathematics behind is slightly different a special mode for this situation is given. In this case you only have to define the trace with a line ROI.

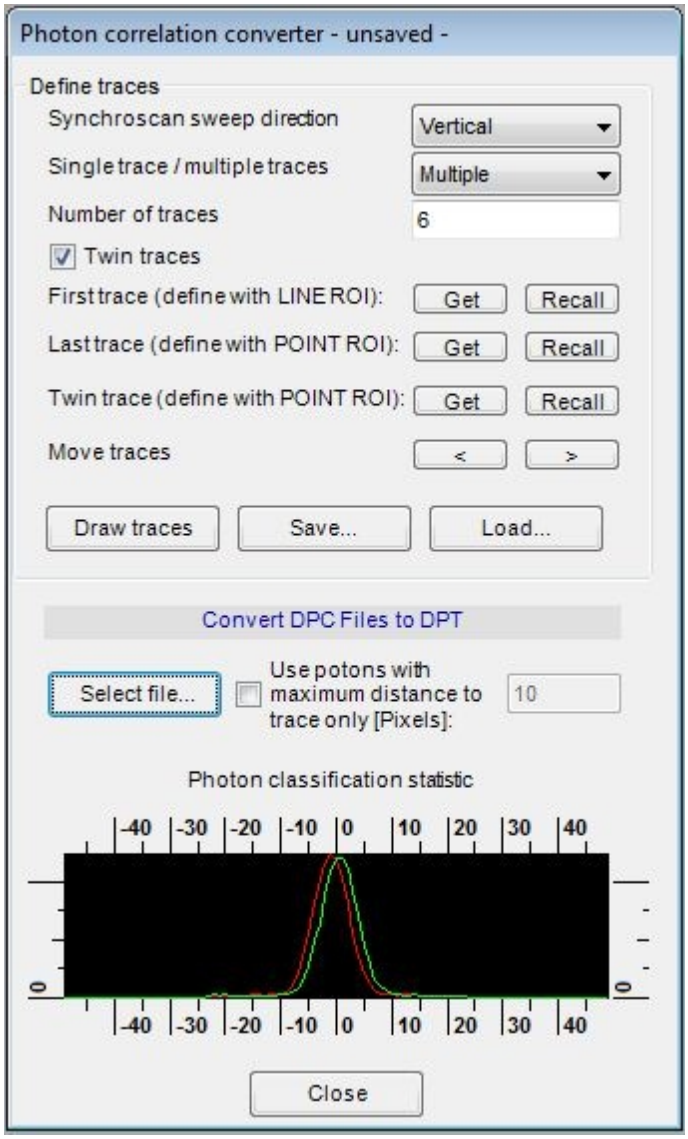


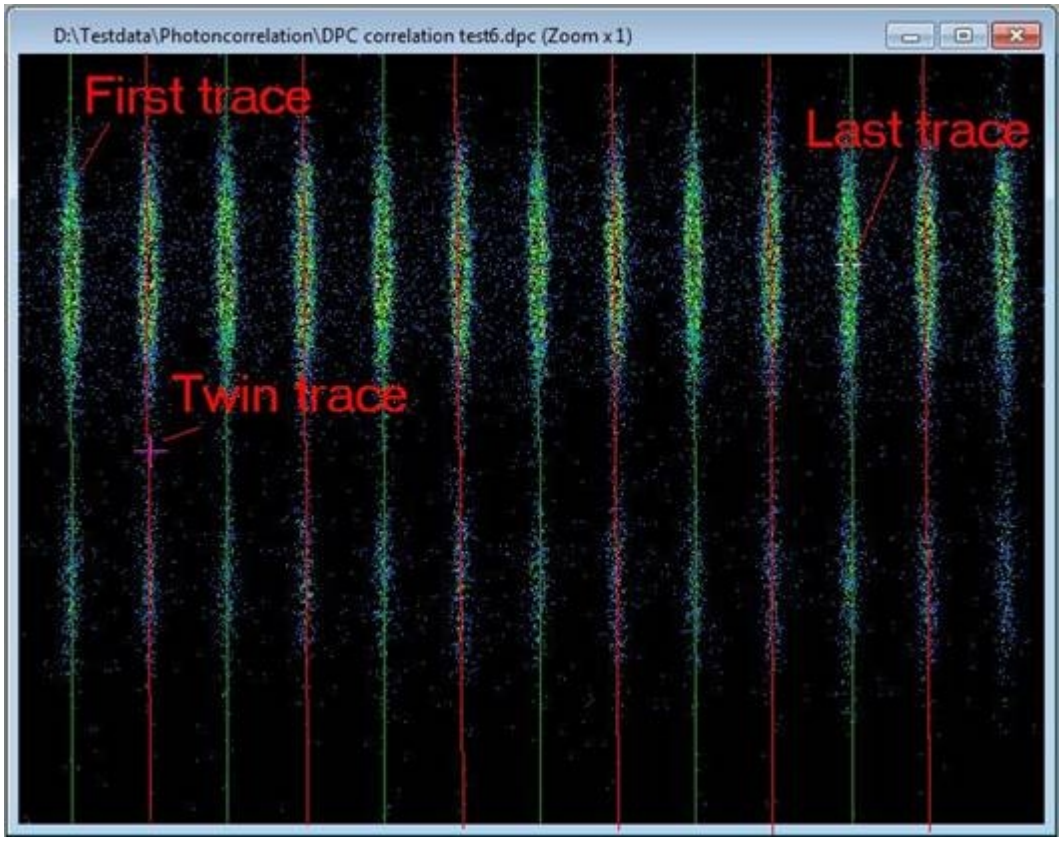
Twin trace mode

Photon correlation measurements

Twin trace mode

Sometimes a second (twin) trace is generated. In such cases the second trace has to be specified similar to the last trace. Be careful to specify a twin trace which is located between the first and second trace.


Photon correlation converter - unsaved -
Define traces
Synchroscan sweep direction
Vertical
Single trace / multiple traces
Multiple
Number of traces
6
Twin traces
First trace (define with LINE ROI):
Get
Recall
Last trace (define with POINT ROI):
Get
Recall
Twin trace (define with POINT ROI):
Get
Recall
Move traces
<
>
Draw traces
Save...
Load...
Convert DPC Files to DPT
Select file...
Use potons with maximum distance to trace only [Pixels]:
10
Photon classification statistic
-40 -30 -20 -10 0 10 20 30 40
0
0
-40 -30 -20 -10 0 10 20 30 40
Close



When converting DPC files to DPT files (see following chapter) two files are generates one has the same name as the DPC file and one has a t added (for twin trace).

Converting DPC files to DPT files

Photon correlation measurements

Converting DPC files to DPT files

Once we have set up the photon traces we can determine the trace number as a function of the x-coordinate within the DPC file. This can be done by executing the Select file... command below the Convert DPC files to DPT section of the Photon correlation converted dialog .

Select a DPC file which has been recorded under the same trace settings as has been setup in the above dialog and select a DPT file. As a default the same file name is suggested with the different ending DPT (Dynamic photon traces).

The program converts all photons to DPT format. While doing so it calculates a statistic of the deviation from the center of the trace and outputs this statistics. We call it photon classification statistic. This statistic can be used to control the process of trace definition and separation. We additionally have the possibility to exclude photons which lay too much outside of the trace. This is a good possibility to exclude crosstalk between the traces. If the traces are well defined the photon classification statistics shown in the graphics should show a symmetric curve with a peak in the center.

To exclude photons which are too far from the trace center we can use the option Use photons with maximum distance to the trace only (Pixel) . To define the maximum distance to the center we have to input a number in pixel. The labeling of the photon classification statistics already gives a hint about the distance of the traces.

Analyzing the trace and time information

Photon correlation measurements

Analyzing the trace and time information

The DPT file contains information about the time of the photon event (This can be done by using the y-coordinate and the scaling information in the file header) and the trace number (x-coordinate) for every single photon event.

The analysis of this data is not the target of the HPD-TA.

Image Display & LUT

Image Display & LUT

This topic contains details of image display and LUT and its operation.

Image display windows

Image Display & LUT

Image display windows

Up to 20 images can be displayed at a time. Each image has its own status. All image processing functions refer to the currently selected image (called "**current image**" in this manual). If you click to an image it becomes the current image.

Each image has its own properties concerning the LUT and color selection.

The image is always displayed within a window with a specific zoom factor. Zoom factors from 1/8 to 8 are available. When the image with the current zoom factor does not fully fit into the window, scrollbars appear on the side and only a portion of the image is displayed.

The whole image displayed

Only a part of the image is displayed

When the window is larger than the area which is needed for the image a part of the window remains white.

When the image is smaller than the display window

You can freely select the size of the window. Sometimes one wants to set the window size to exactly match the image size. In such case it is sufficient to double-click to a grey area on the image window or to select the image and press the function key F2. When the window is smaller than the image there is a small grey area on the lower right corner where one can click.

The caption of the window contains information about the image (image mode, file name, zoom factor). Some functions resize the window automatically so that the image fits into the window automatically (e.g. Acquire, Open.., Background Subtraction).

Caption

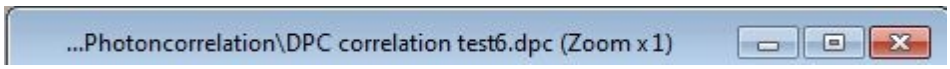
Image Display & LUT > Image display windows

Caption

The image caption shows the image file name and the zooming factor.

If the image is not yet saved a default name is assigned derived from the acquisition with which it has been created and the internal image number.

If the string to display is longer than the available space it is truncated from the left and cutted at the directory borders:



Zoom

Image Display & LUT > Image display windows

Zoom

When the Zoom tool is selected the left mouse buttons can be used to change the zoom factor. The zoom factor is increased by a factor of approximately 1.4 when clicking with the left mouse button to the current image area. The zoom factor is decreased by a factor of two when clicking with the left mouse button while holding down the shift key.

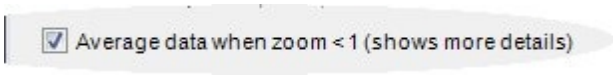
The zoom factor ranges from 1/8 to 8.

The point where the user clicks to the image becomes the centre point of the image. Thus

when you want to magnify a certain location it is sufficient to click to this location with the left mouse button.

If there are scroll bars on the right or bottom side of the window, just a part of the image is displayed. The scroll bars can be used to scroll to a location which is currently not displayed. It is however more convenient to zoom out with the left mouse button while holding down the shift key until the portion of the image which should be displayed becomes visible. Then click to this location with the left mouse button to magnify it.

There is an option **Average data when zoom<1 (shows more details)**in the image options:



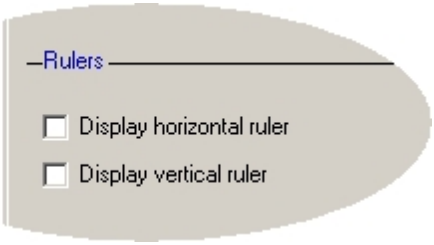
If this option is checked and the zoom factor is less than 1 the display data of neighboring pixels are averaged. If the zoom is smaller than one single pixels or lines with the width of 1 could be otherwise completely hidden. The computational expense is higher if this option is checked but the display precision is higher and the noise appearing in the image is reduced. This option is off as default.

Rulers

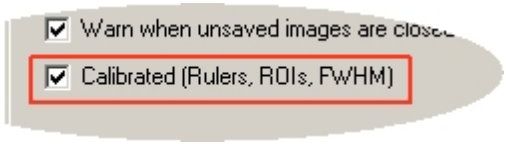
Image Display & LUT > Image display windows

Rulers

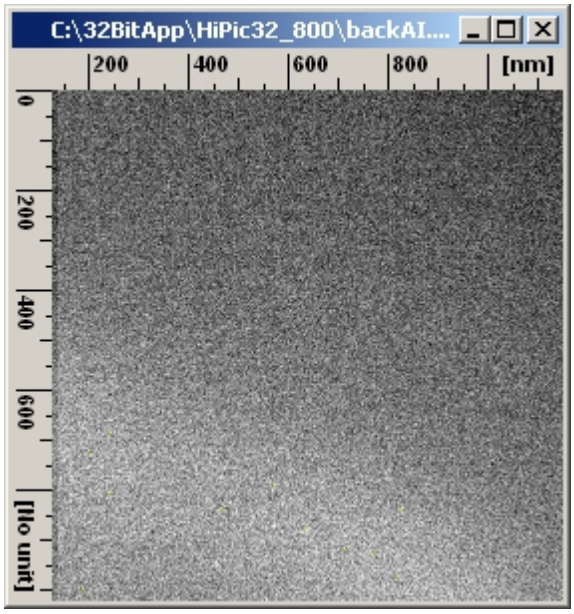
Rulers can be used to display pixel numbers or physical units in the image. To show or hide rulers open the images options (right click in the image display and select Options).



To select whether the rulers should display calibrated units or pixels select the calibrated checkbox.



After closing the Images Options with OK all images contains the desired rulers.



Quickprofile

Image Display & LUT > Image display windows

Quickprofile

The quickprofile is a profile which is directly displayed on the image window and updated with every new image display.

The quickprofile always shows the profile data extracted from the image based on the rectangular ROIs in this image.

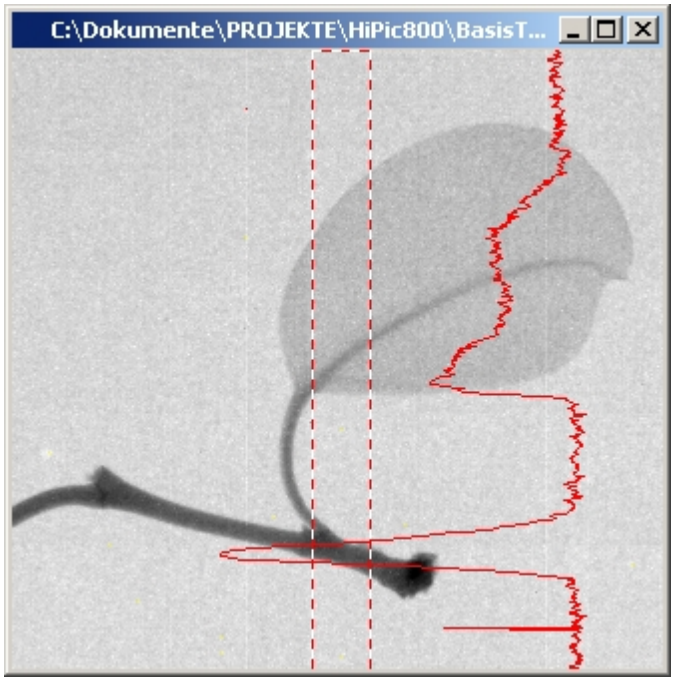
Rectangular ROIs with full horizontal width (═) are always displayed as a horizontal profile.

Rectangular ROIs with full vertical height (‖) are always displayed as a vertical profile.

Arbitrary rectangle ROIs can be either displayed horizontally, vertically or not displayed. These three possibilities can be selected in the quick profile options:

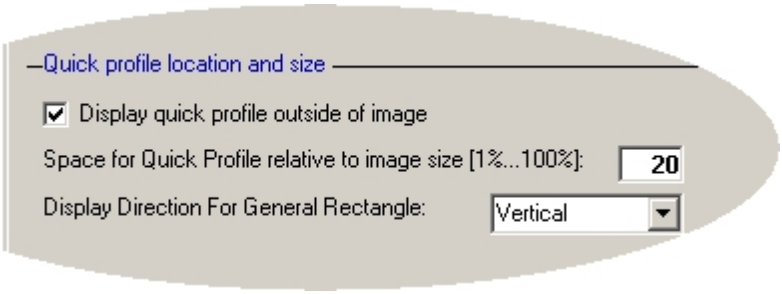
To switch on the quick profile display toggle the status of the quick profile pushbutton on the toolbar or click with the right mouse button on the image display and select Quick Profile.

Normally the quick profile is displayed on the same area as the image.

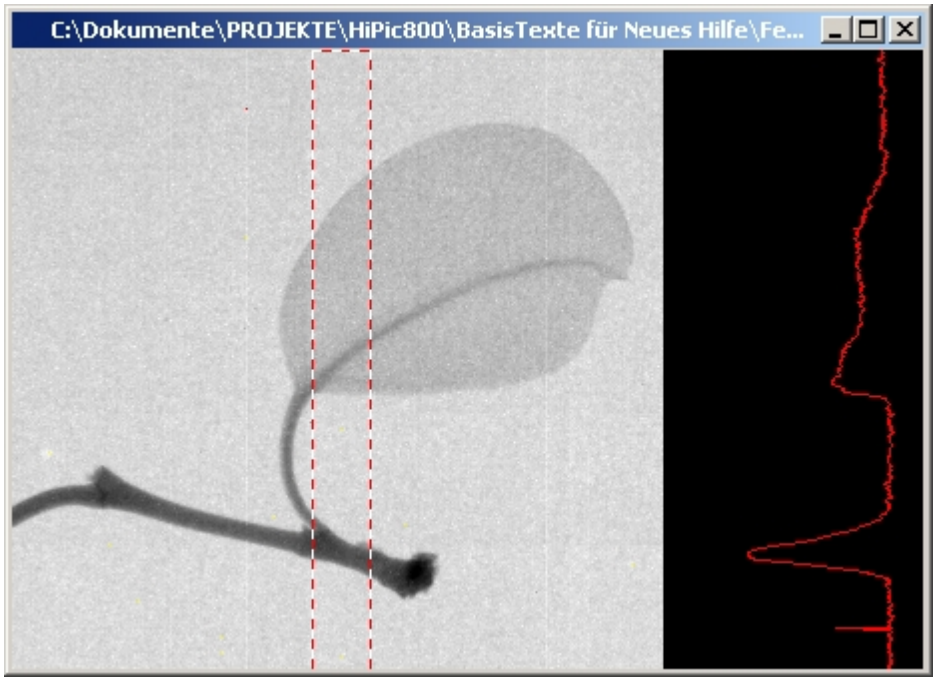


Alternatively the quickprofile can also be displayed in a separate area outside the image display area. To select this alternative call the quick profile options and select Display quick profile outside of image.

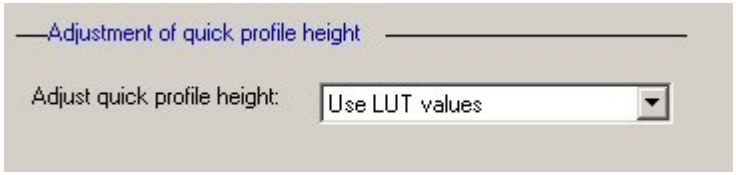
Additionally the user must specify how large the display should be. A percentage has to be specified which determines how large the quick profile are should be relative to the image size.



The quick profile then appears outside of the image.

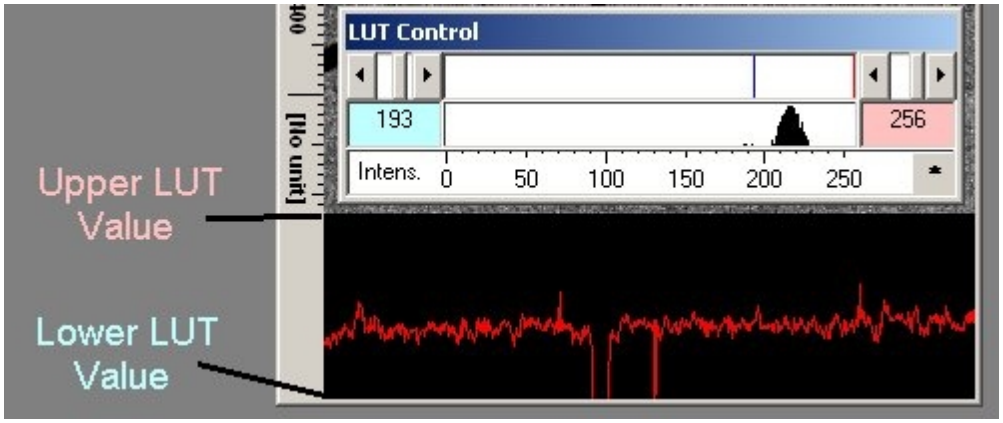


The size of the quick profile depends on the option settings for Adjust quick profile height:

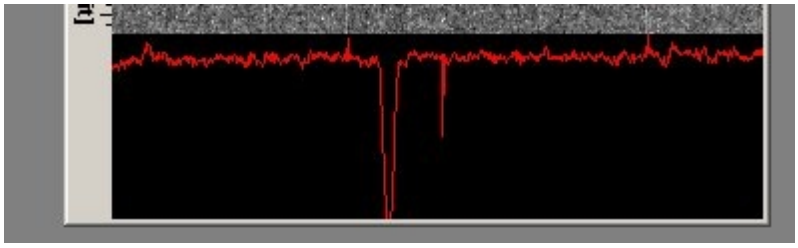


If Use LUT values is selected the upper and lower LUT limits are used as the limiting values. Portions of the quick profile which are beyond these limits are no displayed because they would lay outside the window which is used for the quick profile (This is either the image display window or a separate window neighboring the image display).

If Use Min/max values is selected the minimum and maximum values are use as the limiting values. In this case the Min/Max of every profile individually is used for optimum display range which mean that the intensities between profile are not comparable. If you want to compare intensities you should select Use LUT values , which apply to all profiles in the same way.



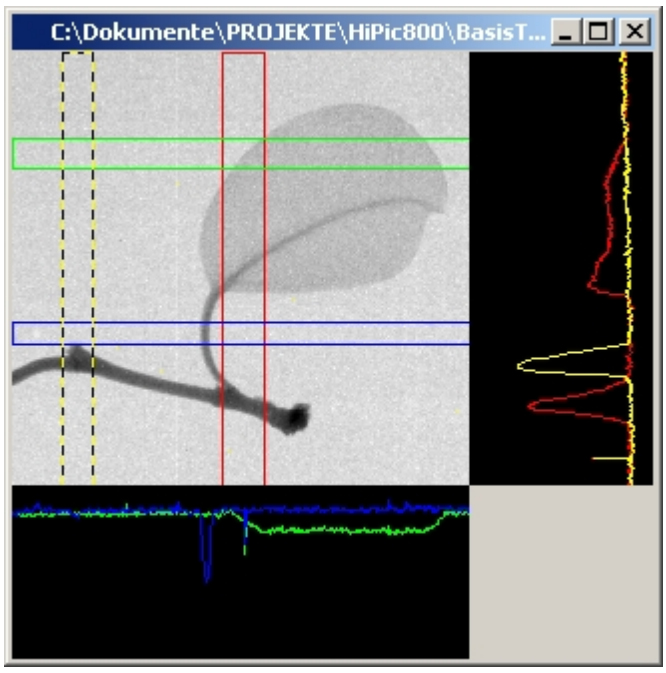
Adjust quick profile height set to Use LUT values



Adjust quick profile height set to Use Min/max values

Different from other functions not only the currently selected ROI contributes to the quickprofile display but all suitable rectangle ROIs. If the quick profile should be displayed outside of the image the outer areas appear and disappear automatically when needed.

Several quick profiles can be displayed in the same window. In this case the relation between ROI and Quickprofil can be easily recognized by the color.



FWHM

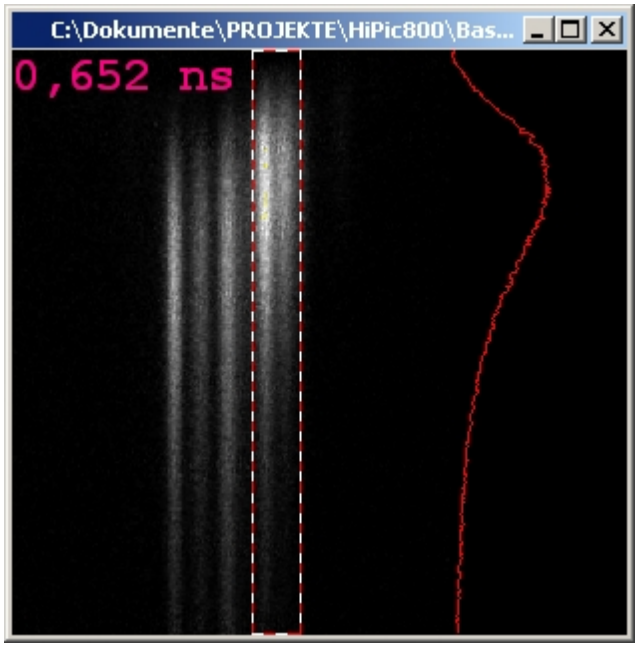
Image Display & LUT > Image display windows

FWHM

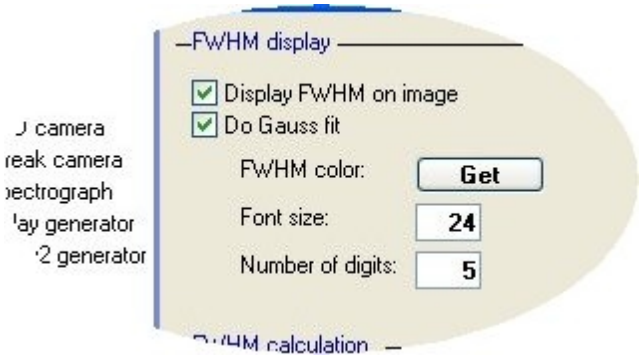
In some specific circumstances the user wants to get a Full width half maximum (FWHM) analysis of the currently selected ROI.

The result will be displayed on the left upper corner of the image.

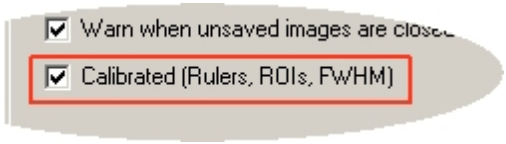
This information can be used for checking and adjustment purposes. If **Do Gauss Fit**is selected, a gauss fir is done and the gauss profile displayed in white. If the fit succeeds the gauss profile is displayed in white color additionally to the profile. If **Do Gauss Fit**is not selected or if the Gauss Fit fails, the conventional method of getting the FWHM is applied. This method searches the half height at both sides from the maximum.



The quick profile options contains some parameters to determine size, color and precision



The decision whether the FWHM should be displayed in pixels or in calibrated units is made in a parameter in the images options:



ROIs

Image Display & LUT > Image display windows

ROIs

Frequently you will have to select special areas on an image. For example you may sometimes want to save only a part of the image. In order to do this you will need a tool to select a special area of the image, a region of interest (ROI).

You can select up to 10 individual ROIs (Region Of Interest) for every image, but only one ROI is the currently active one.

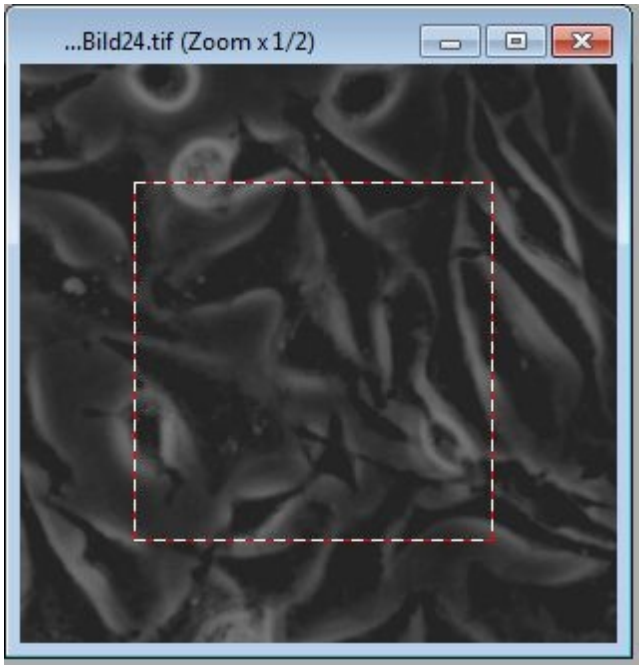
Types of ROI

Types of ROI

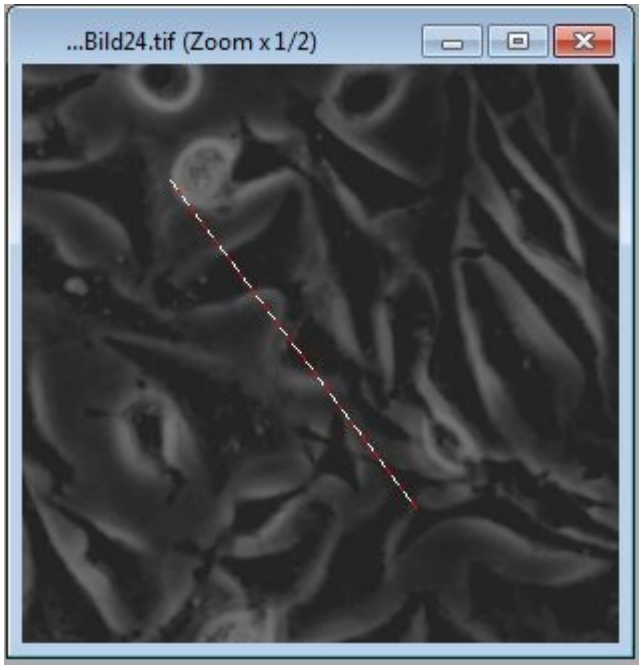
There are different types of ROIs which can be used for different purposes. The types of ROIs are:

	Rectangle ROI
	Arbitrary line ROI (this includes line ROIs with width > 1)
	Point ROI
	Rectangle ROI with full size in horizontal direction
	Rectangle ROI with full size in vertical direction

A Rectangle ROI is a ROI which starts at any arbitrary point and ends at another arbitrary point. The two points are combined to yield a rectangle ROI.

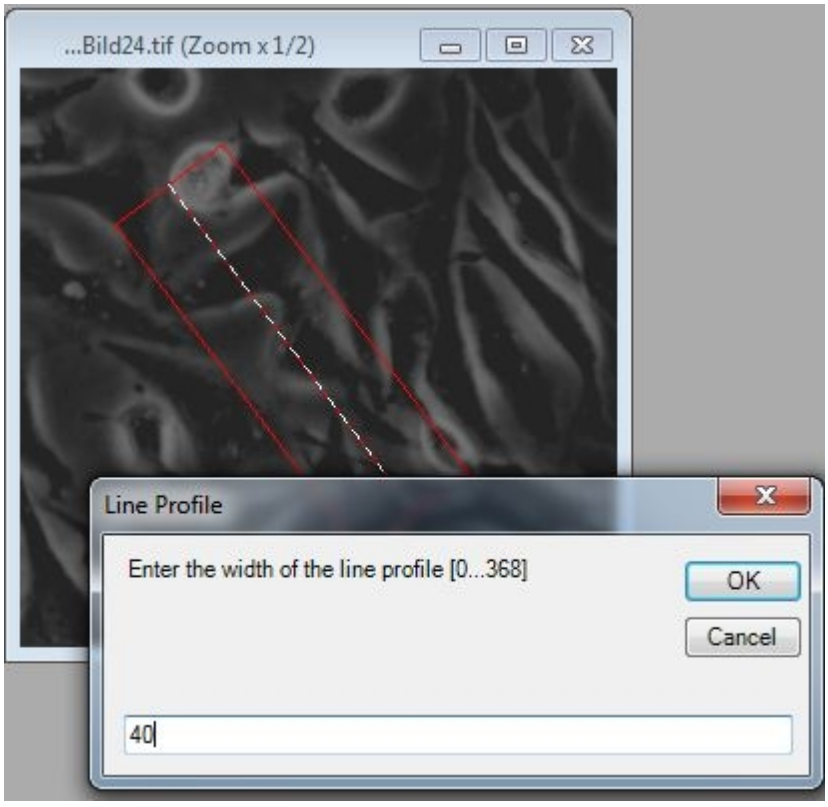


A Line is a ROI which starts at any arbitrary point and ends at another arbitrary point. The two points are combined to yield a rectangle.



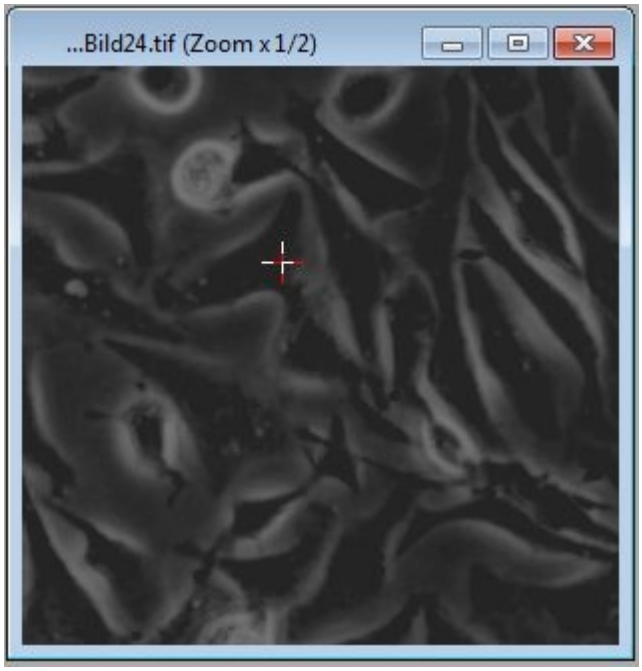
Per default this ROI has the width 0. To get an ROI with a width > 0 there are two methods:

- Enter the letter w. A dialog appears asking for the with, informing the user which range is suitable for this operation.

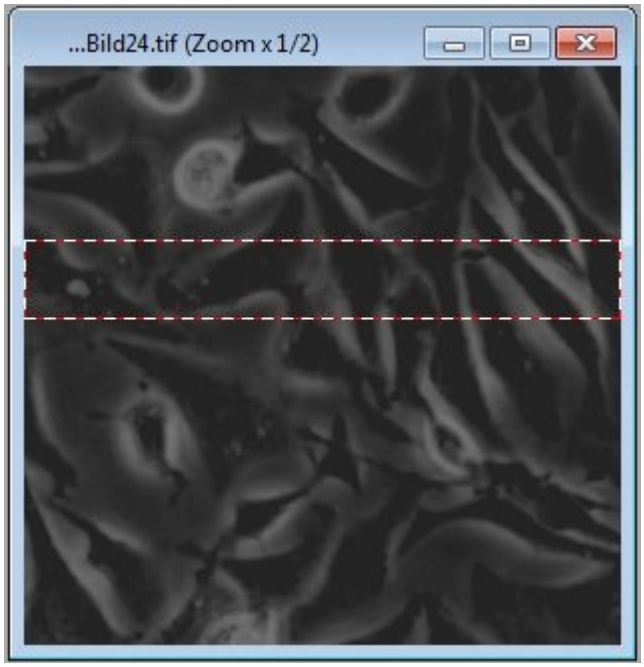


- While holding down the CTRL key click to the image. The ROI will be expanded accordingly

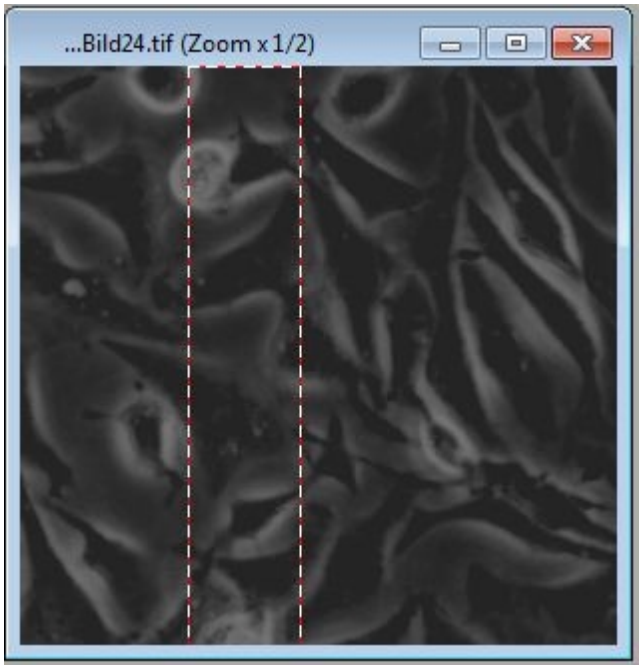
A point ROI is a ROI defined at the point where the mouse is clicked.



A Rectangle ROI with full size in horizontal direction is a ROI which extends to the full horizontal width but can be arbitrary in its vertical starting and ending point.



A Rectangle ROI with full size in vertical direction is a ROI which extends to the full vertical height but can be arbitrary in its horizontal starting and ending point.



Create ROI

Image Display & LUT > Image display windows

Create ROI

To create a ROI first of all select the ROI type on the toolbar:

Then draw the ROI with clicking to the starting point with the left mouse button, then draw the mouse to the end point of the ROI and release it. Once a ROI is created the ROI toolbar automatically switches to the pointer tool.

Move/Resize/Delete

Image Display & LUT > Image display windows > Create ROI

Move/Resize/Delete

To move the ROI select the Pointer on the ROI toolbar (after creation of a ROI this is automatically selected), click on the image display with the left mouse button and move the mouse. If several ROIs are defined this click may select another ROI. In this case a second click is necessary to move the ROI.

To delete the currently selected ROI activate the image by clicking on its caption and type the Del Key or the d key.

To resize a ROI hold down the shift key and click and hold down the left mouse button and move the mouse until the ROI has the desired size. When additionally the CTRL key is hold down, the ROI will become square or in case of a line ROI it will have 0, 45 or 90 degree, whatever will be closest.

Alternatively a ROI can be moved by using the cursor keys (left, right, up, down) in combination with the CTRL key. Each time you press one of the keys the ROI is shifted by 1 pixel.

If you press the Shift and CTRL key + one of the arrow keys, the lower right corner will be shifted (ROI size is changed).

If you want to expand an ROI over the entire horizontal or vertical image area, you can select an ROI and press H to extend the ROI over the maximum horizontal area, or V to extend it over the maximum vertical area, or F to extend it over the full image.

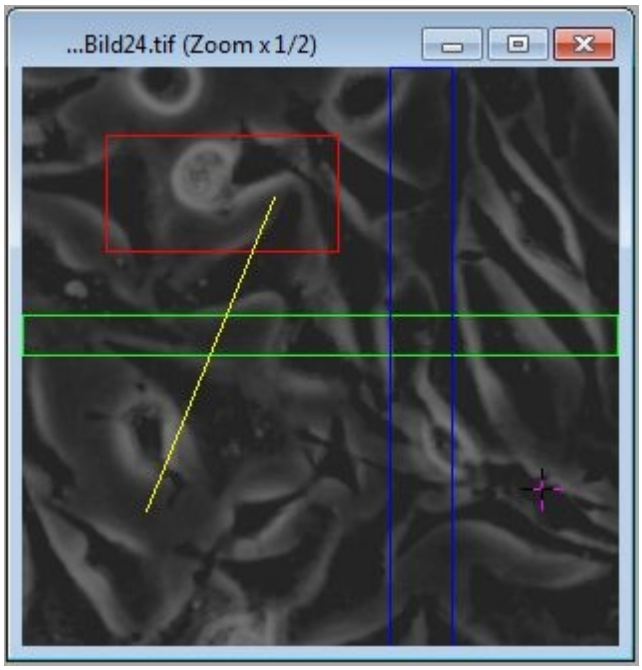
To precisely position or size an ROI the ROI Interface can be used.

Multiple ROIs

Image Display & LUT > Image display windows > Create ROI

Multiple ROIs

If the user wants to select several ROIs he has to select the desired ROI type again and create the next ROI as he did with the first one.



Select/Delete

Image Display & LUT > Image display windows > Create ROI

Select/Delete

Always one of the ROIs is the selected one and every image processing function (like the Save ROI as) is always using the selected ROI. The selected ROI is drawn with as dashed line.

A maximum of 10 ROIs can be selected at once and every ROI has its individual color.

To select a ROI different from the currently selected one just click with the mouse on or near the ROI or use the n key to change to the next ROI. Typing the n key (next) selects all ROIs one after the another.

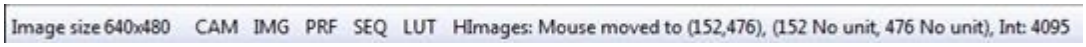
Typing the Del-key or the d-key always deletes the currently selected ROI and automatically selects another one if there is still any ROI which is active.

Mouse Coordinates

Image Display & LUT > Image display windows

Mouse Coordinates

While the mouse cursor is inside of an image window, the co-ordinates and the intensity value at the current mouse position are displayed.



Status display including actual pixel intensity information.

ROI I/F

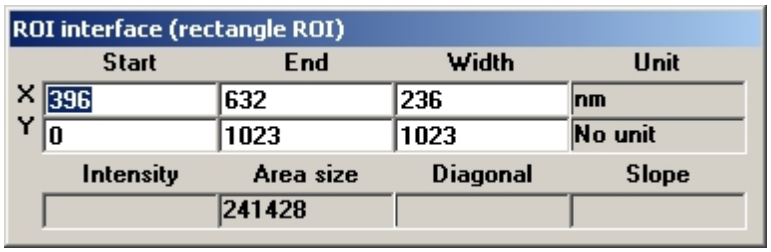
Image Display & LUT > Image display windows

ROI I/F

The ROI Interface is a dialog which is designed to precisely define or read the coordinates of the currently selected ROI of the currently selected image.

To show the ROI I/F toggle the state of the ROI I/F button.

The ROI I/F will appear on screen and show the coordinates of the currently selected ROI. Changing the Selected ROI will automatically update the information in the ROI I/F.



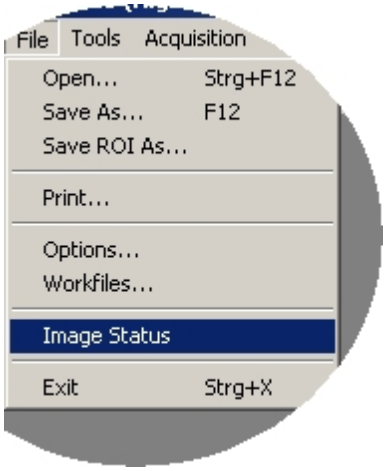
Depending on the type of ROI either only the Start values (point ROI), or Start and End values (Line ROI) or Start, End and Width values (All three types of rectangle ROIs) can be inputted.

Image Status

Image Display & LUT > Image display windows

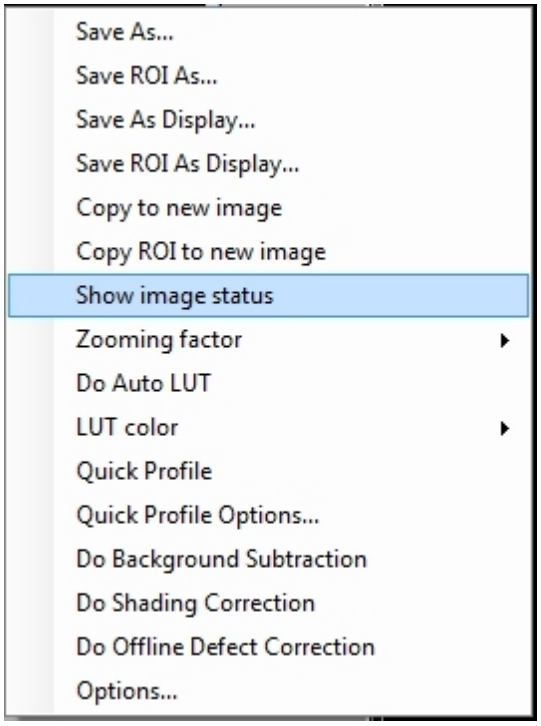
Image Status

Every image contains information about date and time, size, camera settings, calibration and many other parameters which are related to this image. To see this information select the Image Status menu from the file menu

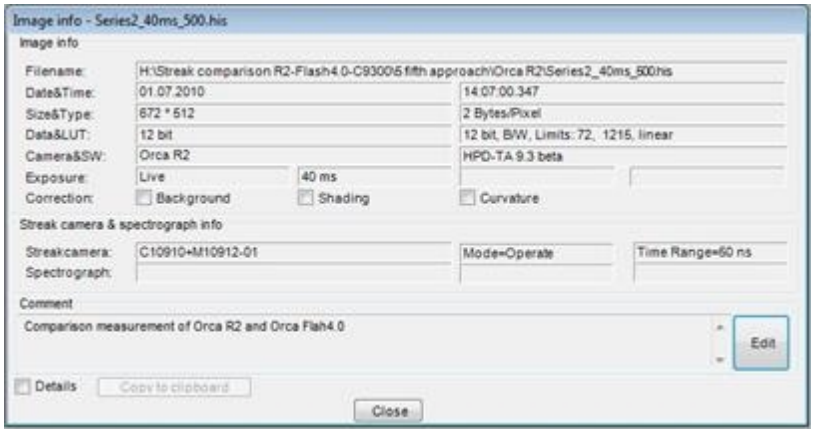


or

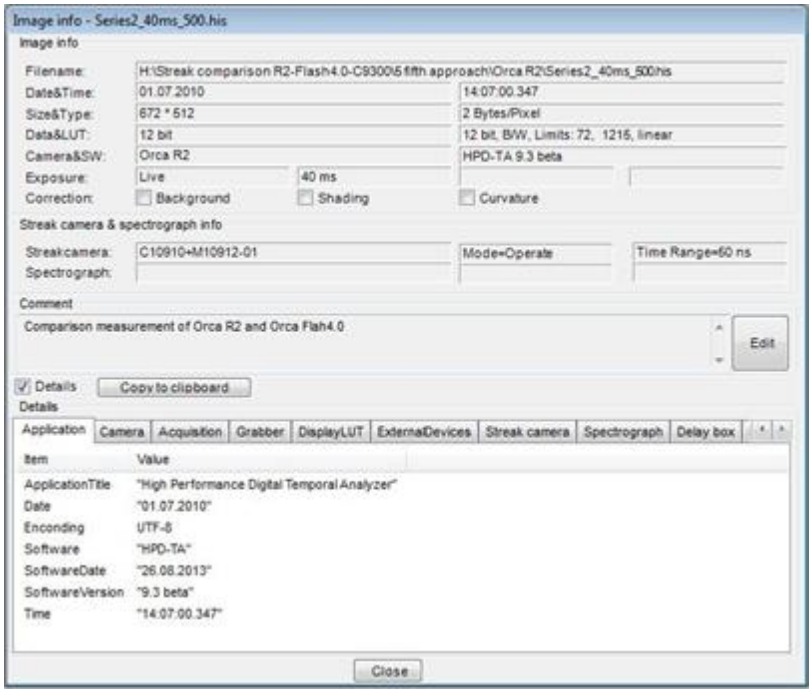
Select the Show image status menu item from the context sensitive menu (right mouse click) from an image display window:



The image status will be displayed on screen.



Details can be shown be clicking on the details checkbox:

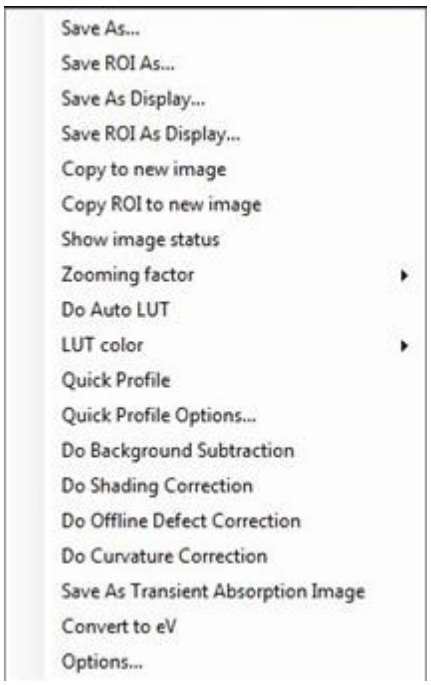


Context sensitive menu

Image Display & LUT > Image display windows

Context sensitive menu

The context sensitive menu which appears if the user clicks with the right mouse button on the image display has the following entries:



Save As	Saves the image to file
Save ROI As	Saves the currently selected ROI of the image to file
Save As Display	Saves the image to file as 8 bit display
Save ROI As Display	Saves the currently selected ROI of the image to file as 8 bit

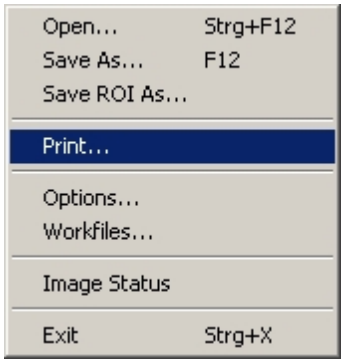
	display
Copy to new image	Copy the current image to a new image.
Copy ROI to new image	Copy the current selected ROI of the image to a new image.
Show Image status	Shows the image status
Zooming factor	Allows to set the zooming factor to the desired value
Do Auto LUT	Executes Auto LUT
LUT Color	Allows to set the LUT color to the desired value
Quick profile	Shows or hides the quick profile
Quick profile options	Shows the quick profile options
Do Background Subtraction	Executes background subtraction
Do Shading Subtraction	Executes shading correction
Do Curvature correction	Executes curvature correction
Options	Shows the images options.

Print Images

Image Display & LUT > Image display windows

Print Images

The currently selected image can be printed by using the print menu command.



A printer setup dialog will appear. Make your selection and Click OK to print the image.

LUT

Image Display & LUT

LUT

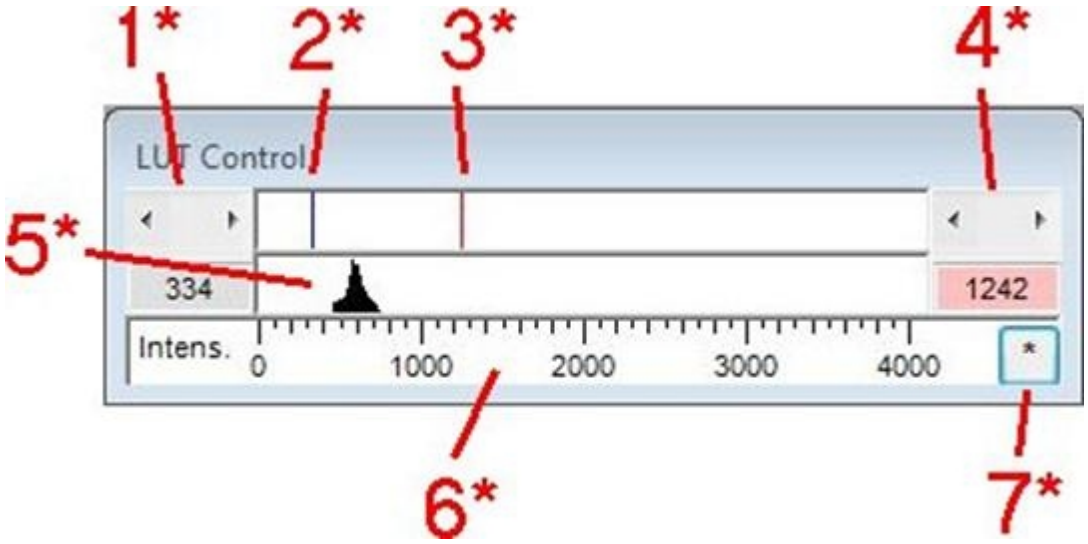
This chapter explains in detail how to use the LUT.

General

Image Display & LUT > LUT

General

The LUT tool is used to control the image display by manipulating its brightness and contrast.



1*: Slide bar to change the lower limit

2*: Lower Limit

3*: Upper Limit

4*: Slide bar to change the upper limit

5*: Histogram

6*: Input intensity scale

7*: Pushbutton for Auto LUT

The LUT Tool

Image Display & LUT > LUT

The LUT Tool

If you acquire images you will find that the images are frequently displayed with too low or too strong contrast. If you acquire images under low light level conditions the display may be too dark. Use the LUT tool to adapt the image display to the desired contrast. This is done by defining the lowest and highest grey value which shall be displayed.

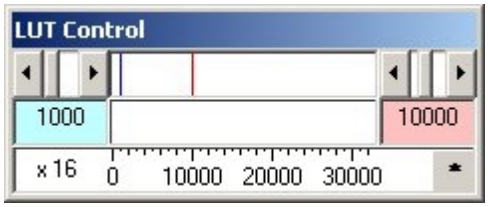
The tool contains an area with two cursors which represents a lower (blue cursor) and an upper limit (red cursor) for the LUT. The meaning of the values of these cursors is described below. The cursors can be moved by clicking next to them and dragging them while the left mouse button is pressed. When you use the right mouse button instead, both cursors will move simultaneously, keeping their distance constant. An alternative way to move the cursors is provided by the two sets of slide bars at the left and right side of the LUT tool. Two display boxes (blue and red) display the exact numerical values of the two cursors.

You can easily see how the image contrast is changed when you change the upper or lower limit as the current image is updated after any change in the LUT control.

The bottom part of the LUT shows a scale representing the input intensity values. In 8 bit mode the scale ranges from 0 to 255, in 10 bit mode from 0 to 1023, in 12 bit mode from 0 to 4095 and in 16 bit mode from 0 to 32767.

At the centre part of the LUT tool (above the scale) a histogram is displayed where the user can see the frequency by which intensity values are present in the image. This histogram can be used as a guide for setting the LUT limits.

The LUT tool is re-sizeable horizontally. If the LUT tool is longer, the intensity scale can be seen and accessed with higher precision but the histogram display will need more time to update.



LUT tool when using 32 bit image data files

When 32 bit image data file format is used (e.g. with 16 bit digital cameras) the string x16 in the lower left corner of the window indicates that the intensity figures shall be multiplied by 16 to give the real intensity data values.

Upper and lower limits

Image Display & LUT > LUT

Upper and lower limits

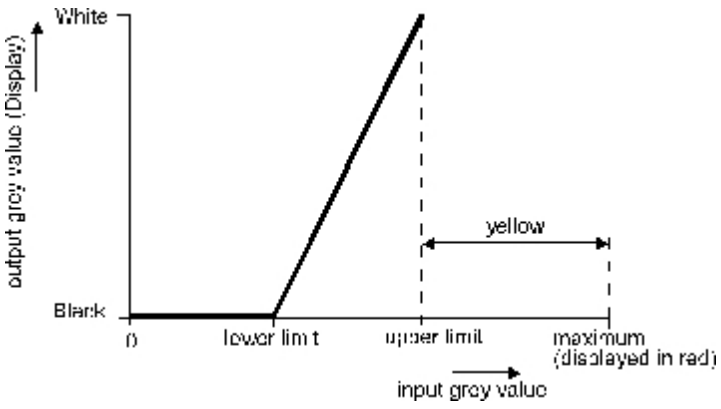
The software allows displaying images either in black and white or in pseudocolor mode (see). The meaning of the LUT limits is explained below for both modes.

Intensity values between the lower and the upper limit are displayed using the full range of the LUT (either in grey-scale or in color). The values above the upper limit (which exceed the current LUT) are displayed in yellow (in case of grey-scale LUT) or black (in case of color LUT).

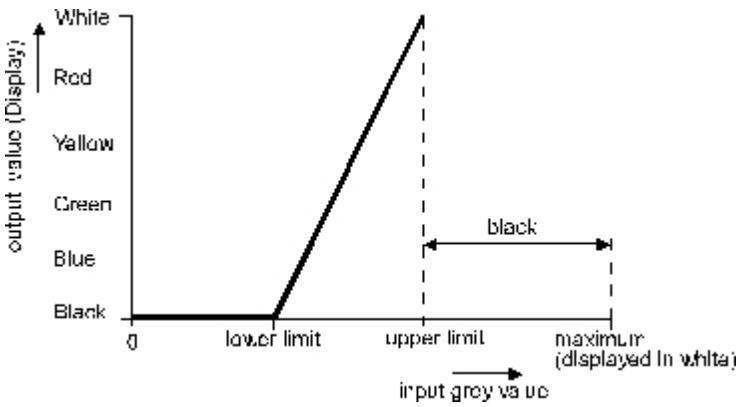
The uppermost intensity value of the current acquisition mode is displayed in red (grey-scale LUT) or in white (color LUT). Areas in these colors indicate an overflow of the CCD camera. For 10 bit images the overflow value is 1023 and for 12 bit images it is 4095. Be sure to reduce your light intensity if you encounter this situation.

Display mode	*Smaller than blue cursor*	*Between cursors*	*Greater than red cursor*	*Saturation*
B/W	*Black*	*Black to white*	*Yellow*	*Red*
B/W inverted	*Yellow*	*White to black*	*white*	*Red*
Pseudocolor	*Black*	*Blue to red*	*Black*	*White*
Pseudocolor inverted	*Black*	*Red to blue*	*Black*	*White*
B/W without using colors	*Black*	*Black to white*	*White*	*White*
B/W without using colors inverted	*White*	*White to black*	*Black*	*White*

Table: Image color-coding in different display modes



Mapping of LUT values for black and white LUT



Mapping of LUT values for color LUT

LUT parameters

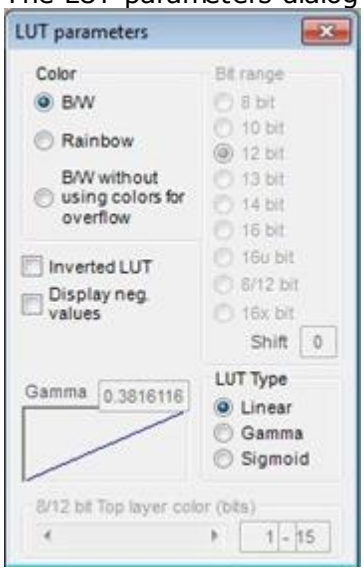
Image Display & LUT > LUT

LUT parameters

With this function you can select several properties of the display like color, linearity or the display of negative values.

Choose **LUT** from the **Display** menu to display the LUT parameters dialogue.

The LUT parameters dialog appears:



LUT parameter dialogue box

Within the dialogue box you can select the LUT type (either black-and-white or rainbow) by clicking to the **B/W** or **Rainbow** radio button in the **Color** frame.

B/W will produce a grey scale display where data overflow is marked by yellow and red color, while **Rainbow** will produce a pseudo-color display where different intensities are coded as different colors. **B/W without using colors for overflow** will produce a grey scale display where data overflow is not marked by yellow and red color.

Warning: When using the program with a streak camera or a camera with image intensifier, you should **not use** the setting **B/W without using colors for overflow**, since it is difficult to recognize over exposure of the tube, which may damage your detector system!

Note: Overflow means A/D overflow of the camera A/D converter or when the range of the data storage type is exceeded.

Inverted look-up table

Image Display & LUT > LUT

Inverted look-up table

It is possible to apply an inverted look up table. This means that all intensity values are inverted (image looks like a negative image).

Display negative values

Image Display & LUT > LUT

Display negative values

In most cases negative images values, even though they may appear due to some operation like background subtraction, may not be of any interest for the display. In very special cases a user may want to display it as well. For this purpose the option Display neg. values is provided. If this option is selected, negative values will be displayed in the same brightness or color as the positive value with the same absolute value.

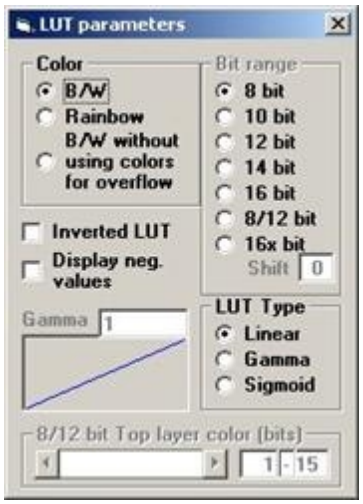
Non-linear contrast enhancement

Image Display & LUT > LUT

Non-linear contrast enhancement

The standard (default) enhancement mode offers a linear enhancement between the lower and upper limits.

Sometimes, however, a non-linear enhancement function may be preferred. This program supports two non-linear modes: Gamma and Sigmoid.



LUT dialogue with linear contrast enhancement

Then set the enhancement factor (gamma-factor or sigmoid factor) by clicking and dragging the enhancement curve in the graphic box. Alternatively you can insert the desired factor into the textbox **Gamma**. Leave the text field with the TAB key to activate the setting.

Choose LUT type according to your desire by selecting the related radio button in the LUT type section.

Set the Gamma or Sigmoid parameters either by clicking in the box where the transfer curve is drawn and dragging the curve (current image will be updated immediately) or by inserting the desired factor in the textbox Gamma followed by pressing the TAB key to activate the new factor.

Optimize contrast enhancement

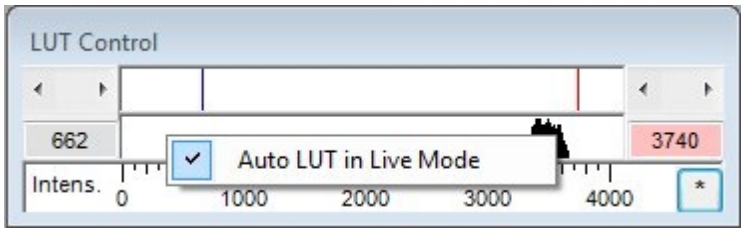
Optimize contrast enhancement

By clicking the small asterisk at the lower right side of the LUT tool or the corresponding button in the menu bar you can force LUT limits being calculated automatically according to the intensity values present in the image. This is an easy way to adapt the LUT settings to the current image and to obtain optimum digital contrast enhancement.

Auto LUT in Live mode

Auto LUT in Live mode

The option Auto LUT in Live mode has a convenient interface. It can be directly accessed with the right mouse click from the LUT tool.



When Live mode is running, the LUT limits are continuously updated. If the user wants to adjust the LUT limits manually, Auto LUT in Live mode stops and the selected values remain active. To re-activate Auto LUT in Live mode just right-mouse click to the LUT control and select Auto LUT in Live mode .

Bird view

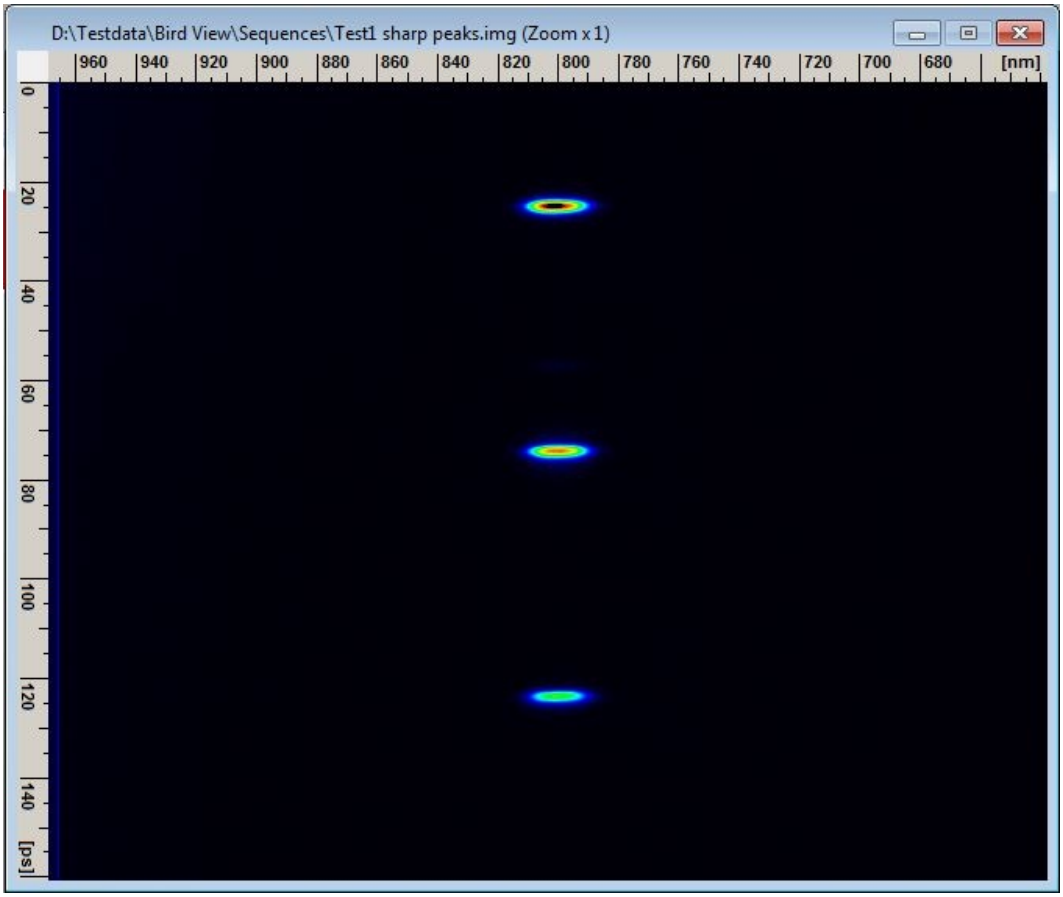
Bird view

Since version 9.4 the HPD-TA supports the bird view display of image data. This is a kind of 3-dimensional view where the intensity becomes the z-axis of the display.

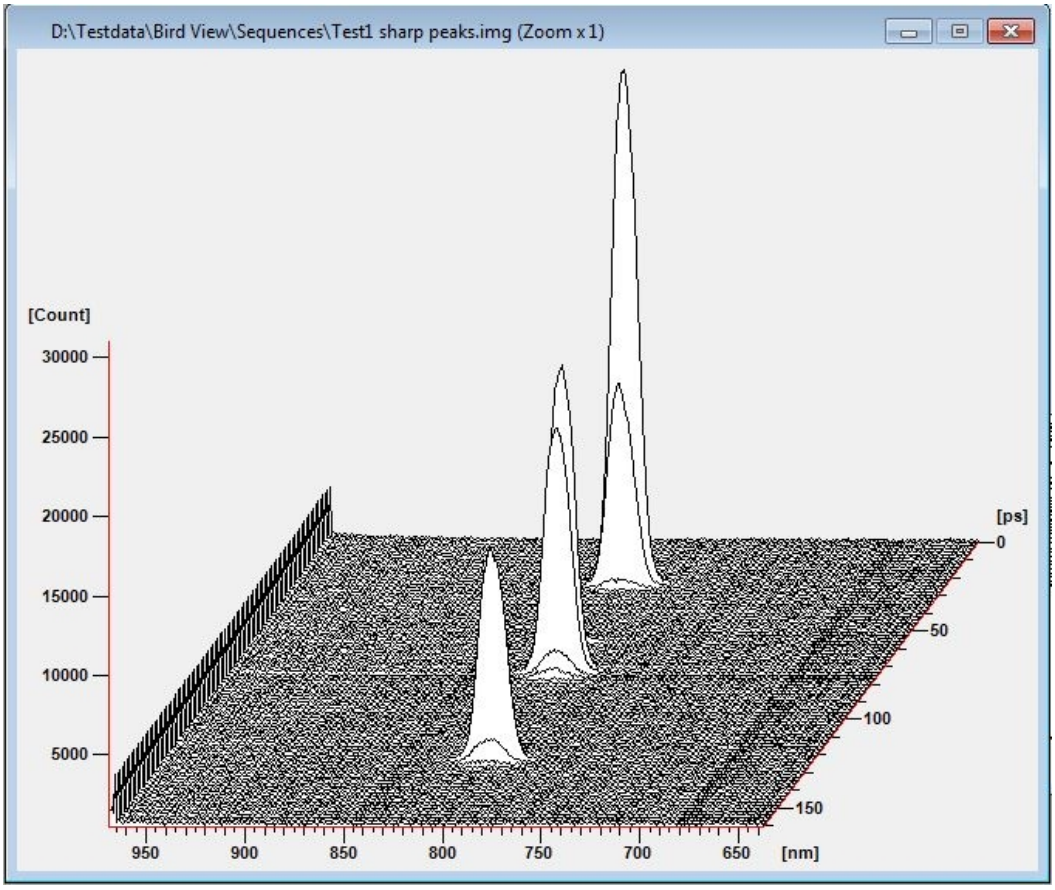
General

General

Normally the image is displayed in a two dimensional way with an grayscale or color LUT representing the intensity.



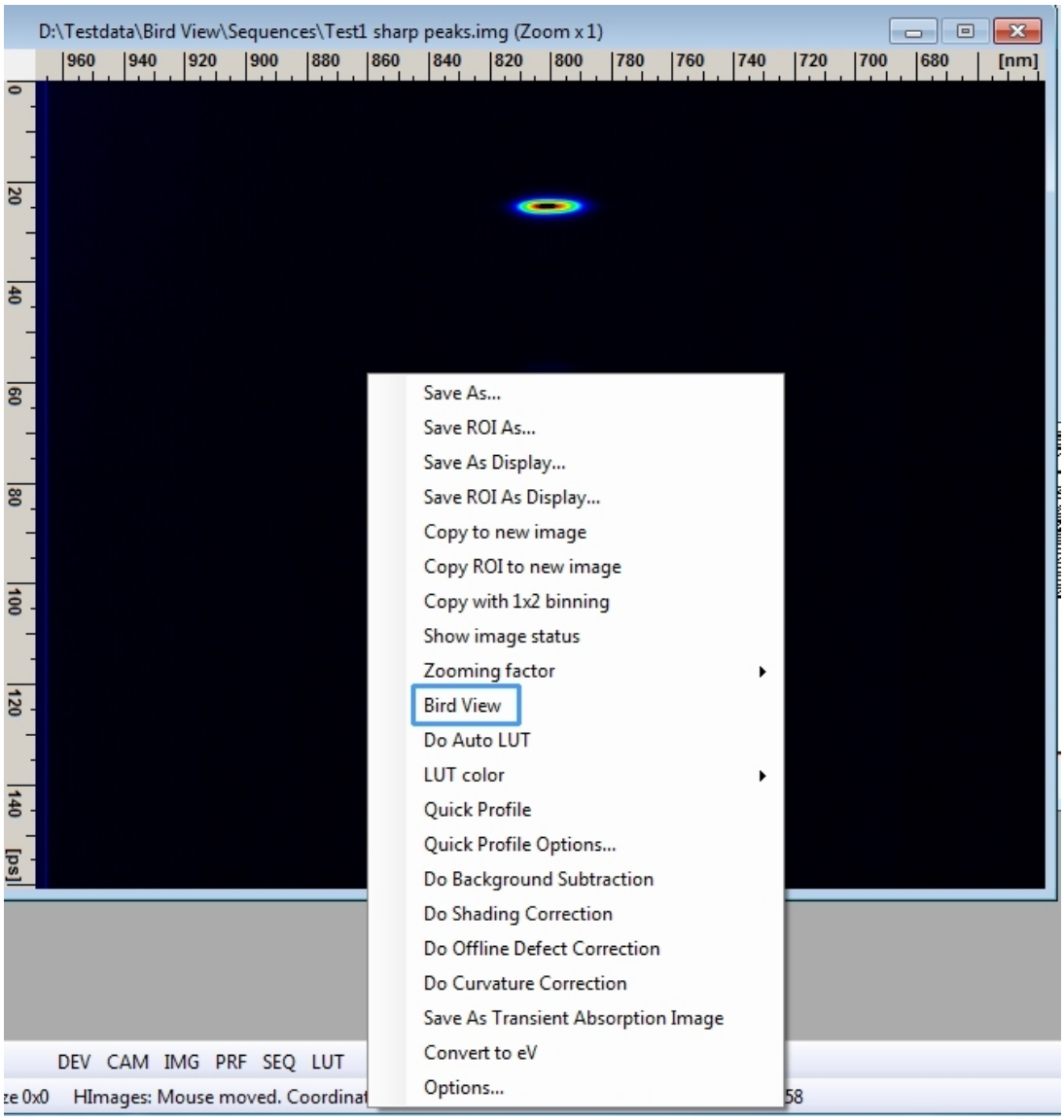
In some circumstances it can be an advantage to see the same image from a bird view perspective



Switching to bird view mode

Switching to bird view mode

To switch to bird view mode the user can use the item Bird View in the context sensitive menu (right mouse click).



If an image has been saved in Bird View mode it is loaded in bird view mode per default.

Graphical details

Graphical details

The user can change several graphical details of the bird view mode.

Window size

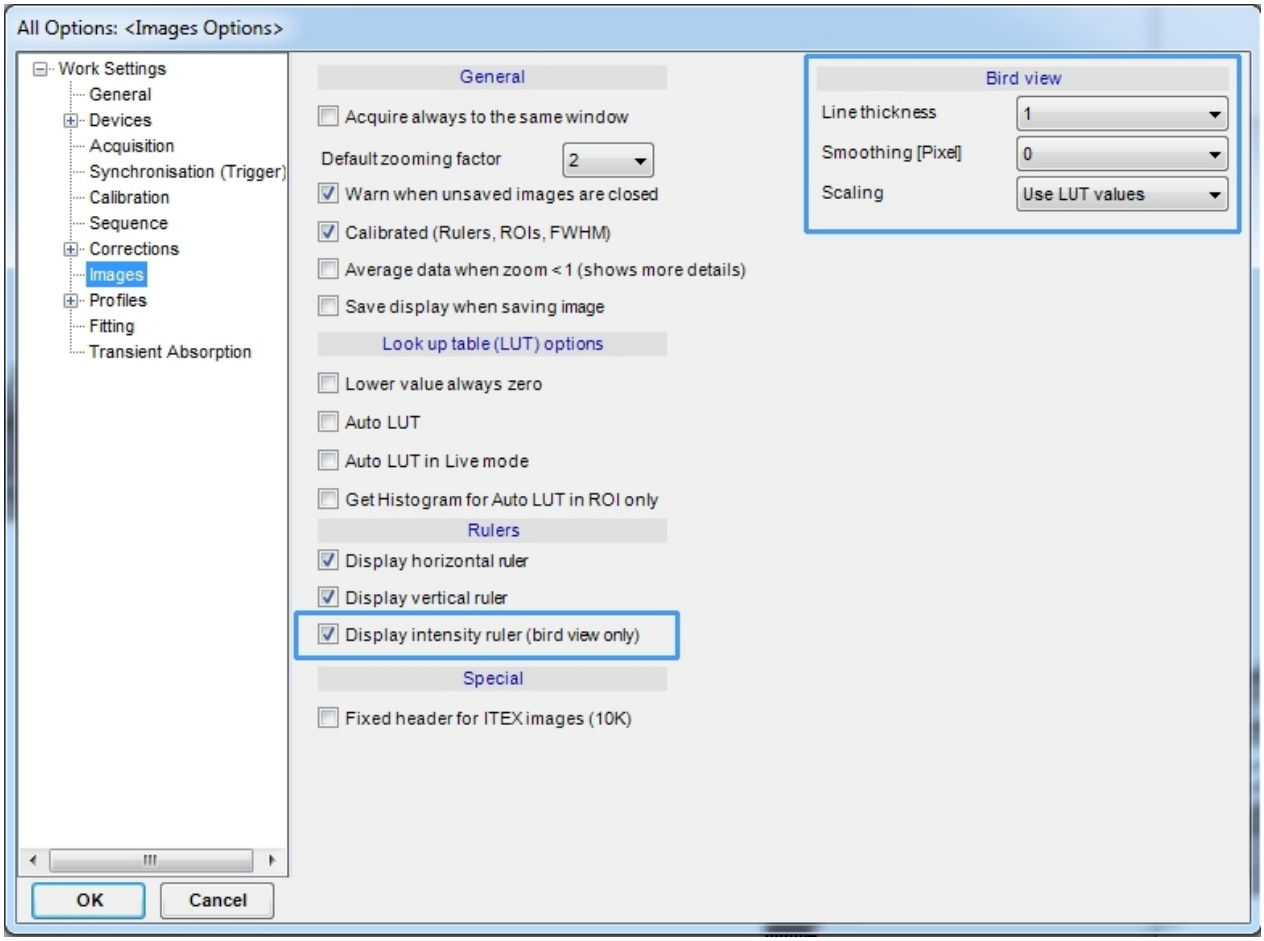
Unlike to the normal image display the aspect ratio of the bird view image is not fixed. The User can modify the size and shape if the final image display by modifying the window size.

Rulers, line thickness and scaling

In the Image Options the user can select whether and which rulers are drawn in the bird view image.

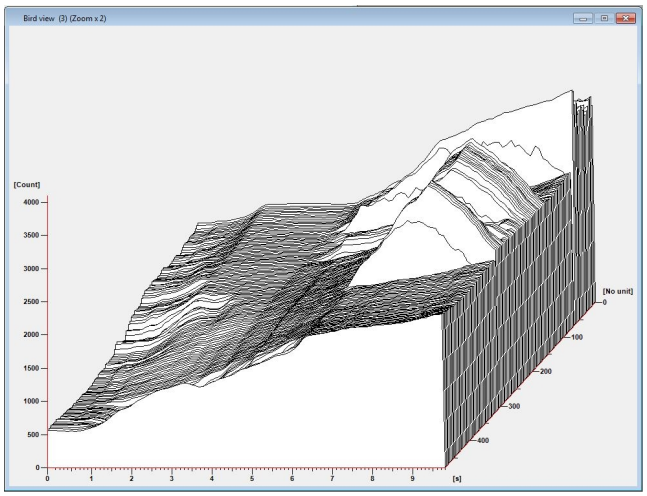
Furthermore he can select the line width of the display and the degree of smoothing.

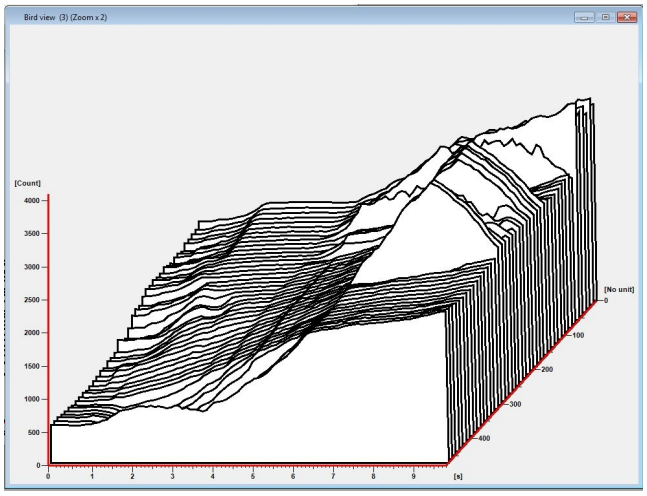
Finally he can choose whether the vertical scaling can be determined by the LUT values or by an automatic algorithm which looks for minimum an maximum values.



Line thickness

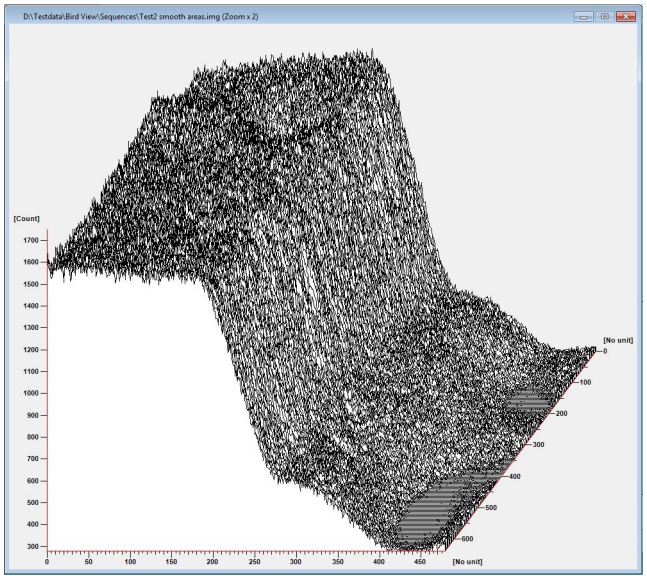
This chapter shows the influence of the line thickness

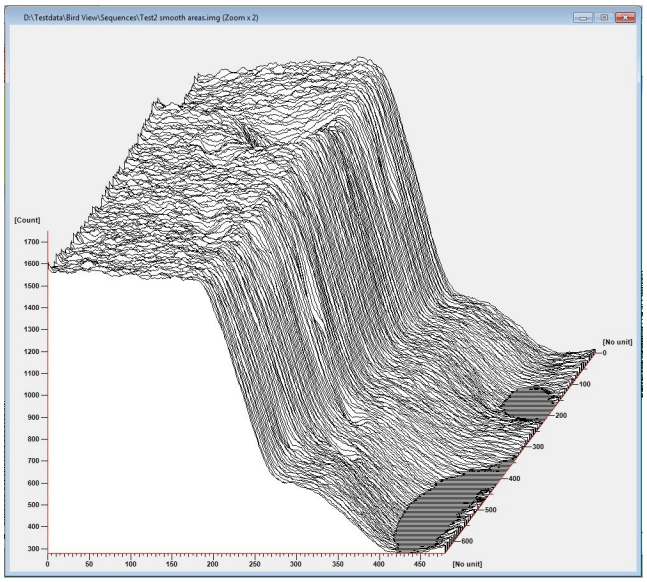




Smoothing

This chapter shows the influence of the line smoothing

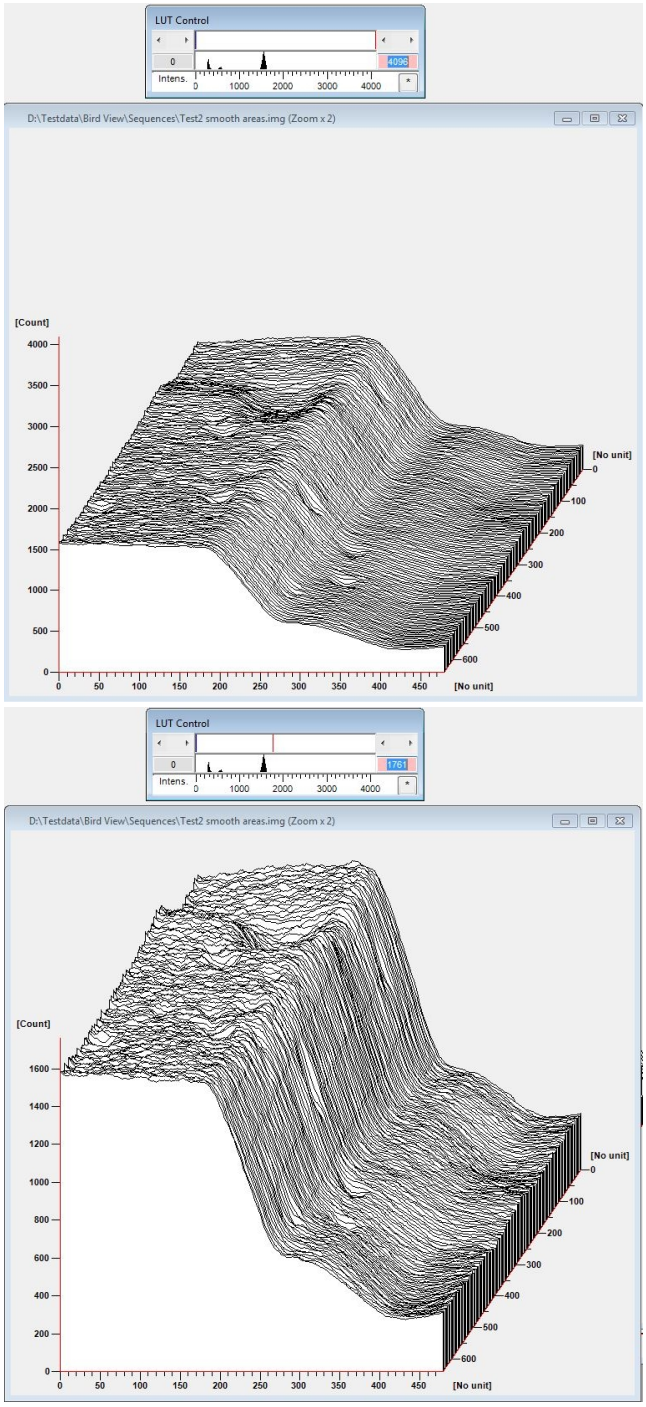




Vertical calibration by LUT

This chapter shows the influence of the LUT on the vertical calibration (If use LUT values is selected for

scaling).



Create bird view image from a sequence

Image Display & LUT > Bird view

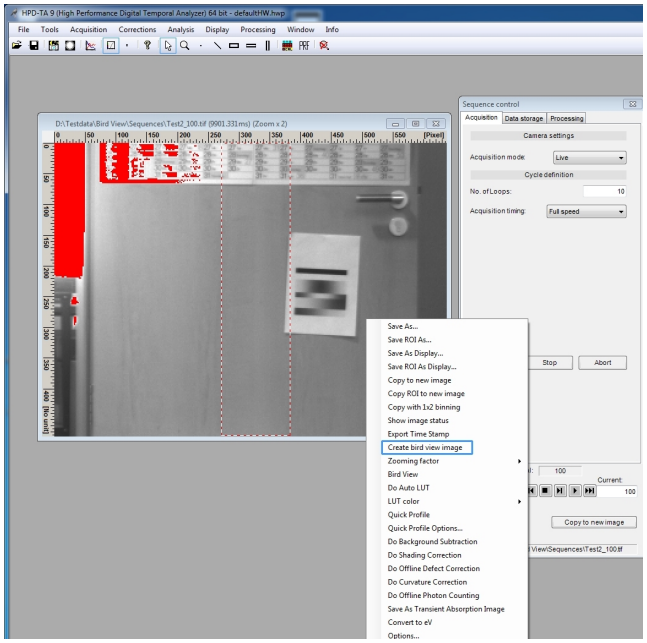
Create a bird view image from a sequence

A bird view image can be created from a sequence, by specifying a full length horizontal or full length vertical profile and then specifying the command "Create bird view image".

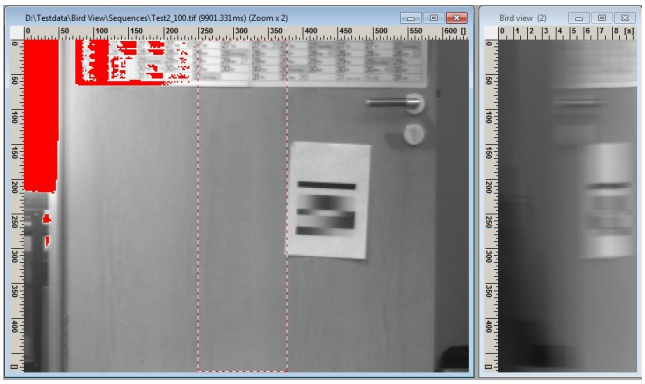
Every single image in the sequence contributes one single line which is extracted from the profile. The result image is then n columns wide (while n is the number of sequence images) if the profile is vertical and n lines high if the profile is horizontal. This axis gets than the meaning of a time axis and will be scaled in seconds.

In our example we have selected a vertical ROI which results in a image which has a widht of n columns.

Original:



Result:



Selecting measurement parameters

Selecting measurement parameters

This topic describes in detail how the user can influence the behavior of measurements and other actions of the program. This is done by so called options.

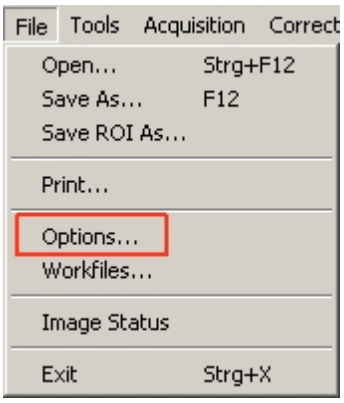
Options

Selecting measurement parameters

Options

All options are accessible from one single options dialog. To call the options menu there are two ways:

1.) Call the options dialog from the menu:



2.) Click with the right mouse button to a dialog where you want to get the related options dialog. If you for example click to the sequence dialog you will get the context sensitive menu for sequence which contains the Sequence options command.

General options

Selecting measurement parameters > Options

General options

Restore window positions	If this option is checked, the program stores the position and size of every window when it is closed. The settings will be restored, when the window is opened for the next time
USER function	When the **UserFunctions** option is checked, function calls to a DLL named CUSTOMER.DLL are enabled. With this option the user can implement his own control and data analysis functions into
Show streak control window	Shows the streak control window
Show delay control 1 window	Shows the delay 1 control window
Show delay control 2 window	Shows the delay 2 control window

CCD camera

Selecting measurement parameters > Options

CCD camera

The CCD camera options dialog shows all options which can be specified to define the CCD cameras operation. Depending on the type of CCD camera these options look different.

Grabber options

Selecting measurement parameters > Options

Grabber options

The grabber options look different for every grabber.

Streak camera

Selecting measurement parameters > Options

Streak camera

Inquire status regularly	If this option is set the system inquires the status of all external devices (streak camera, delay generators, spectrographs) every second
Auto streak shutter	If **Auto streak shutter** is selected the streak shutter will be always automatically opened when an acquisition is started and automatically closed when the acquisition ends. This feature can be used to prevent the streak camera of being exposed to incident light when no measurement is under progress. We strongly suggest to use this feature, if applicable, to help avoiding accidental damage or tube burn-in.
Auto MCP	If **Auto MCP** is selected the MCP gain as previously set by the user will automatically be set when an acquisition is started and automatically set to the minimum value when the acquisition ends. This is also a function which helps to protect the streak tube when no measurement is under process.
Auto delay (streak camera)	If **Auto delay (streak camera)** is selected, the delay parameter in the streak camera s control box will be saved when you change the time range and restored when the time range is used the next time.

Delay options

Selecting measurement parameters > Options

Delay options

Auto delay (delay box)	If **Auto delay (delay box)** is selected, the current settings of a delay unit will be automatically saved when you change the streak camera time range. These parameters will be set again, when you return to this time range later.
Reset stored values	Press **Restore stored values** to reset all stored values to the currently selected values.
Copy values to Clipboard	This functions copies the AutoDelay values associated to the different time ranges to the clipboard. From there they can be imported in Microsoft Excel or similar programs
A list of all delay parameters	When the check box left of the parameter name is checked the value will be switched automatically.

Acquisition

Create 32 bit images when camera has 16 bit	Create 32 bit images when camera has 16 bit. If this option is not set, an unsigned 16 bit image is created. This allows much higher performance especially with large images with high frequency. In the case of modern CMOS cameras please unselect this option. The default value of this option is off.
Wait till next display in LIVE mode [ms]:	Displays a new live image only if the specified time in ms has been elapsed since the last displayed image.
32 bit images in Analog Integration	If this option is set result images in Analog Integration mode will always be 32 bit. Note: If the camera outputs 16 bit images the resulting images will be always 32 bit images (to allow storing signed values) independent of this option.
CCD Gain for Photon Counting	This option allows specifying the default CCD camera gain setting in photon counting mode. You can select between Maximum gain and Minimum gain . It is recommended to use Maximum gain unless the photon spots get saturated. The CCD gain can also be modified manually.
Write Dynamic Photon Counting file	If **Write dynamic photon counting file** is selected, the recording of photon counting images in the special DPC file format is enabled. In a DPC files the x-y co-ordinates of each photon and the time when it has been detected are recorded. This allows making a time dependent analysis of photon counting images.
Default DPC file name	This file name is suggested, when the option Write Dynamic Photon Counting file is active and Photon counting is started. In RemoteEx this option can be used to select the Dynamic Photon Counting file.
Write binary profile (file name is derived from DPC file name)	This option is only valid in combination with writing DPC files (see above). When this option is active the system writes a binary profile (with extension bpr) from a predefined ROI with every new frame. Further to the dpc and bpr file the system writes some other files. If all these files are available the system can than perform a frame to frame jitter correction on the DPC data using the binary profiles to get the fix points. Please see the chapter Jitter correction with DPC files and binary profiles .
Get area	The Get area pushbutton allows to specify the ROI which is used by the Write binary profile function. A full length ROI has to be specified in the direction of the streak sweep **before** entering the options dialog.
Recall area	The Recall area pushbutton allows to recall the ROI which is

	used by the Write binary profile function. An appropriate image has to exist **before** entering the options dialog which will then contain the ROI.
32 bit images in Photon Counting	If this option is set result images in Photon counting mode will be 32 bit. Otherwise the result images will be 16 bit images.
Moiré reduction	This option specifies how strong Moiré reduction should take place. It is recommended to keep this parameters at its default value Standard .
Detect cosmic ray during PC setup	This option excludes frames which are much higher than average when performing PC setup. This option should normally be on. In rare cases the average of the CCD signal varies so strongly that normal PC setup fails. In such cases this option should be switched off.
Additional timeout [sec]:	The parameter **Additional timeout (sec)** can be used to define an additional timeout, after which an image acquisition will be stopped, if no response comes from the camera. Usually this time should be 0. Only in some special case when you get timeout errors before an image acquisition has been finished, you may increase this parameter. Normally the timeout is automatically calculated: Timeout = System defined timeout (derived from the exposure time) + Additional timeout (sec). This parameter is very rarely needed in the current version of the software.

Synchronization (trigger) options

Selecting measurement parameters > Options

Synchronization (trigger) options

Synchronization method	The **Synchronization (trigger) options** dialog allows selecting the most suitable synchronization configuration for your application and hardware. You can choose among 3 synchronization methods: Enclosing method, Sequential method and CCD Master
Reset delay [us]	The value entered for the **Reset delay (µs)** specifies the delay between the "monitor out" and the "reset in" pulses in microseconds when working with edge trigger mode of the CCD camera. The default setting of 1500 microseconds should work for all Hamamatsu streak cameras. The value can be decreased in some cases in order to achieve higher repetition rates (contact Hamamatsu for details on specific streak cameras). The minimum value is 1.
Post trigger time [ms]	The value entered for **Post trig. time (ms)** specifies the time, for which the acquisition still continues after the specified number of triggers are counted. This is useful for very long time ranges or if some afterglow of the streak cameras phosphor screen has to be integrated.
Exp. time for seq. trig + CCD Master [ms]	This value specifies the exposure time used for the CCD camera when sequential trigger or CCD Master is used.

	Note: Depending on the range of values for the CCD camera the closes value is selected
Use Dual Time Base Extender	Defines whether a Dual time base extender should be used. Note: If this parameter is not selected the parameter blanking amp of a dual time base extender cannot activated, but will be set to off automatically by the software.
Connect monitor out	Defined where to connect the monitor out signal
Connect reset in	Defined where to connect the reset signal

Calibration

Selecting measurement parameters > Options

Calibration

Horizontal	Calibration for the horizontal direction
Vertical	Calibration for the vertical direction
Current system calibration	The currently active calibration for the complete system
Focus Mode Calibration	Calibration in the direction of the streak sweep in focus mode
Fixed scaling w/o spectrograph	Scaling is used for the direction perpendicular to the streak sweep if no spectrograph scaling is active.

Sequence

Selecting measurement parameters > Options

Sequence

Prompt before start	Normally a sequence acquisition is not started immediately after you click **Start Acquisition** in the sequence acquisition dialogue. Before the acquisition actually starts, an initialization procedure is executed. If **Prompt before start** is selected, the system will display a message box after the initialization is completed. Sequence acquisition will be started immediately after you click OK in this message box. This is useful if you want to precisely control the starting time of sequence acquisition.
Enable stop	If **Enable stop** is selected, it will be possible to stop sequence acquisition at any time. If it is not selected, sequence acquisition can be stopped only by the user function. Of course sequence acquisition will stop latest when the pre-selected number of images has been acquired. If **Enable stop** is selected, the sequence acquisition may be slightly slower on older computer.
Enable wrap around in Acquire to RAM mode	If **Enable wrap around** is selected, the sequence function will allow to acquire a sequence in the wrap around mode. This function is only available, when the **Enable stop** is selected.
Acquire to RAM:	Number of buffers used for acquisition to RAM as an

Number of buffers	intermediate storage between acquisition and the applications sequence RAM. These buffers are normally managed by the frame grabber driver.
Display Interval for acquisition to RAM [ms]	Interval in ms which have to pass before a new sequence image is displayed. The acquisition continues during this time. This can reduce the CPU load for display images especially for high rep rate images and improve acquisition performance.
Do not attempt to load a sequence to RAM	Normally loading a sequence will always try to load the sequence to RAM. If this succeeds operations and display can then be executed at maximum speed. However if after loading a part of the sequence there is not enough RAM all images are unloaded and only checked. If normally the sequences are too large to fit into the RAM this is just waste of time. If the option **Do not attempt to load a sequence to RAM** is active the system does not attempt to load the sequence.
Number of buffers	Number of buffers used for fast hard disk recording as an intermediate storage between acquisition and hard disk write. These buffers are normally managed by the frame grabber driver. If the streaming engine is used (see below), this number also defines the number of buffers used by the streaming engine.
Use streaming engine	If this option is selected a powerful streaming engine is used, which operates in a separate thread. It is recommended to keep this setting.
Load HIS sequences after acquisition	HIS sequences are always written to a file. If this option is active the file is automatically selected as the current sequence.
Pack 10 and 12 bit images (increases performance)	10 and 12 bit images are packed internally, which increases the saving speed and the storage depth. **Warning:** If you want to perform background subtraction with the option Clip to zero during background subtraction not selected (in other words: if you want to create signed data) in a later step you should not use this option.
Always display image during acquisition	If this option is active the image is always displayed during the acquisition process. **Warning**: this option may slow down the recording speed !
Warning on	If warning on is active a display shows the remaining time in seconds until the next acquisition starts. Additionally the background color of the main window changes to red shortly before the next acquisition starts. This option is only effective of Fixed intervals with a long interval is specified.
Play interval	Defines the time in ms between two images for the display in play mode.
Wrap during play	If during play of a sequence it encounters an end it restarts from the other end and runs continuously.
Do auto corrections after sequence	If the checkbox **Do auto corrections after sequence** is checked, all correction functions, as background or shading correction, are performed after a complete sequence has been acquired. A background image will be acquired only once at the end of the sequence. If this checkbox is unchecked, the corrections will be made after acquisition of each image. It may depend on your experiment, which mode to use: The mode **Do auto correction after sequence** allows a much faster processing of an image sequence. We recommend using it as default. However there

	may be circumstances which do not allow to use this mode, e.g. if the background image is changing after each acquisition. Then it is better to perform background subtraction immediately after an image has been acquired with a newly acquired background image.
Processing arithmetic:	Defines the way how average images are processed. The user can select between Conventional, Average and Add. See the chapter Sequence acquisition Processing Sequences- Arithmetic for details.
Correction direction for images	Defines the direction of jitter correction for images
Search fix points in profile # (profiles only)	In the case of jitter correction for profiles fix points are searched in the specified profile number.

Background

Selecting measurement parameters > Options

Background

Background source	Defines the source of the background data. Available choices are Camera or File.
Use individual background images for every acquisition mode (special case only)	When we select to use File as a background source we can furthermore select whether we want to specify one single file for all acquisition modes (default) or whether we want to specify a different file for every acquisition mode. This can be useful if scanning options link scan speed are different in different acquisition modes.
Take background image with open shutter	Normally the CCD cameras shutter is closed during background subtraction from camera. If this options is selected the background image is taken with open shutter.
Don't prompt the user before backgr. sub.	If **Don t prompt the user before backgr. sub**is not selected the user is prompted to close any external shutter or switch off the illumination light or take a similar action to avoid that the light signal comes to the camera during background acquisition. If the option **Don t prompt the user before backgr. sub** is selected the user is **not** prompted to take any such action and Background subtraction immediately proceeds.
Background file for: Live	File for background subtraction in Live mode
Background file for: Acquire	File for background subtraction in Acquire mode
Background file for: Analog Integration	File for background subtraction in Analog Integration mode
Add constant after background subtraction	You can add a **constant** during background subtraction process. This is especially useful when normal acquisition

	modes are used and negative values would be clipped to zero. By adding a constant you will see the image noise correctly even in dark areas. To add a constant during background subtraction processing you simply enter the desired offset value in the edit box **Add constant after background subtraction**. If you add a positive constant it may happen that the current bit range is exceeded. In this case the values are clipped to the maximum possible value within the bit range (e.g. 255 in 8 bit images, 1023 in 10 bit images and 4095 in 12 bit images). Therefore it is recommended to choose a constant not higher than necessary (the amount of noise is normally only a few counts). The constant is used for "from camera" type subtraction as well as for background subtraction "from file".
Clip to zero during background subtraction	Negative intensity data may appear after background subtraction. If this command is selected, negative intensity data are clipped to zero.
Auto background subtraction	When the **Auto Backsub** option is checked, background subtraction is automatically performed after an image acquisition. Please refer to for details about Background subtraction.

Shading

Selecting measurement parameters > Options

Shading

Shading file	Image file used for shading correction
Shading constant	This option defines the method how to get the shading constant: If Calculate Automatically is selected, the software calculates the constant according to the image data in the inner part of the shading image. If Use upper LUT value of Shading file is selected, the upper LUT value of shading file is used as the constant. Note: In this case the upper LUT value within the shading file has to be selected correctly prior to saving the shading file.
Auto shading correction	If this options is selected a shading correction is executed automatically after image acquisition
Spectral sensitivity correction	If this options is select a spectral sensitivity correction is executed together with the shading correction
Lamp file	This file specifies the spectral intensity distribution of the lamp

Defect pixel

Selecting measurement parameters > Options

Defect pixel

Defect pixel correction	If this options is selected defect pixel correction is executed
Defect pixel correction file	This file specifies the coordinates of the defects for the defect pixel correction

Curvature Correction

Selecting measurement parameters > Options

Curvature Correction

Curvature correction file	File to specify the parameters fro curvature correction.
Auto curvature	When the **Auto Curvature** option is checked, curvature correction is automatically performed after an image acquisition.

Images

Selecting measurement parameters > Options

Images

Acquire always to the same window	When the option **Acquire always to the same window** is selected the **Acquire** and **Analog Integration** functions always use the same image window for acquisition. This is useful to avoid that the PC memory is quickly used up for storage of images. The default behavior concerning new images is as follows: The Live mode always acquires to the same window. The image load function opens always a new image. The Acquire and Analog Integration function opens up a new window every time they are invoked.
Default zoom factor	When a new window is opened a default zooming factor is used for the display.
Warn when unsaved images are closed	When a window is closed and the image is not or not fully saved the program issues a warning prior to closing the window (default). When the checkbox is not selected the program does not issue such a warning.
Calibrated (Rulers, ROIs, FWHM)	Defines whether the labeling of Rulers ROIs and FWHM are in calibrated units or in pixels.
LUT lower side = 0	When this option is checked the lower limit of the LUT will always be set to 0 when automatic LUT calculation is executed (e.g. by pressing the * button of the LUT tool or by using AUTO LUT mode). If the option is unchecked the lower value will be calculated according to the data.
Auto LUT	When the **Auto LUT** option is checked the LUT is adapted automatically during image acquisition (e.g. during analog

	integration and photon counting), after acquisition, background subtraction and loading an image.
Auto LUT in LIVE mode	When this option is checked the image contrast will be updated by the AUTO LUT function whenever a new image is displayed in Live mode.
Get Histogram for Auto LUT in ROI only	When this option is checked the Auto LUT function will optimize the image contrast for grey values which are within the boundaries of the actual ROI. This allows optimizing the contrast based on the grey levels within a limited image area. If no ROI is selected, the whole image area will be considered as actual ROI. This function will be only active if Auto LUT is enabled.
Display horizontal ruler	Defines whether or not a horizontal ruler is displayed in the image
Display vertical ruler	Defines whether or not a vertical ruler is displayed in the image
Display intensity ruler (birdview only)	Defines whether or not an intensity ruler is displayed in the bird view display
Fixed header for ITEX images (10K)	The image status information is stored in a string in the image file header. Normally the length of this string varies with its content. However, in some cases it is desired that the header has a fixed length. If this option is checked the length of the header is always 10K.
Bird view - line thickness	Defines the line thickness of the bird view display
Bird view - smoothing	Defines how smooth the display of the bird view is drawn. If the noise of the image data is large this could improve the bird view drastically.
Bird view - scaling	This defines the scaling of the vertical position within the bird view. If selecting Use LUT values the upper and lower end position for display is defined by the LUT values. If use Min/Max values the upper and lower end position for display is defined by the minimum and maximum value of the data.

Quick profile

Selecting measurement parameters > Options

Quick profile

Display FWHM on image	Defines whether or not a FWHM value should be displayed in the image
Do Gauss Fit	If Do Gauss Fit is selected, a gauss fir is done. If the fit succeeds the gauss profile is displayed in white color additionally to the profile. If Do Gauss Fit is not selected or if the Gauss Fit fails, the conventional method of getting the FWHM is applied. This method searches the half height at both sides from the maximum^.
FWHM color	Defines the color in which the FWHM letters should be displayed
Font size	Defines the Font size in which the FWHM letters should be displayed

Number of digits	Defines the precision with which the FWHM should be displayed
Use minimum as zero for FWHM	Defines whether or not the Minimum of the profile should be used as the zero point for FWHM calculation
Display quick profile outside of image	Defines whether or not the Quick profile should be displayed outside of the image. If not it is displayed at the same area than the image.
Space for Quick Profile relative to image size [1%...100%]:	Defines how large the space for the quick profile should be relative to the image size. This option applies only to cases where the Quick Profile is displayed outside to image.
Display direction for general rectangle	This option defines whether and how an arbitrary rectangle should have a Quick Profile display or not. Possible values are: Don t display, Horizontal, Vertical
Adjust Quick profile height	Defines how to adjust the height of the displayed quick profile. If Use LUT values is selected the upper and lower LUT limits are used as the limiting values. If Use Min/max values is selected the minimum and maximum values are use as the limiting values.

Analysis profiles

Selecting measurement parameters > Options

Analysis profiles

Show analysis cursors	When Show analysis cursors is selected, two cursors appear on the **Profile Display** Window and the **Profile Analysis** window appears on the screen.
Detailed analysis	If the **Detailed analysis** is selected under the **Options** menu several additional numerical values will be displayed.
Use minimum as zero	For some functions the "zero point" has to be determined. By default this point is exactly at intensity =0. However, if the option **Use Minimum as zero** under the **Options** menu is selected the minimum found in the region between the two cursors is regarded as the zero point. This is very useful if the profile contains an undesired offset.
Scaled display	When **Scaled Display** is active, the scaling data attached to the profile is used to get the correct physical value for every data point. If **Scaled display** is inactive corresponding pixel values are displayed. With this option you can even display profiles with different units. All analysis values are displayed in scaled values or in pixels according to this option.
Background black	**Background black** determines whether the profile background will be displayed black or white.
Auto zoom	If **Auto zoom** is selected, the system performs a zoom operation whenever a profile has been changed. This ensures that always the best display mode is selected to show all actual profiles within the display window with maximum size (like the Zoom all button).

Y-Axis	There are three different possibilities for display of the intensity axis. It can be either displayed linear or logarithmic with the base 10 or with the base e. This can be selected by choosing one of the options **Linear, Log(base e)** or **Log(base 10).**

Fitting

Selecting measurement parameters > Options

Fitting

Logarithmic display	Defines whether or not all profiles are displayed with a linear or logarithmic scale
Show excitation pulse	Defines whether or not the excitation pulse is displayed or not
Factor	Defines the relative display factor of the excitation pulse
Show residuals	Defines whether or not residuals are displayed
Show autocorrelation	Defines whether or not the autocorrelation function is displayed
Show fitting trace	Defines whether or not the fitting trace window is showed
Weight function	Defines the weight function fro the fitting process. Possible values are Gauss or Constant

Hardware profiles

Selecting measurement parameters

Hardware profiles

The HPD-TA has a convenient feature to switch between different hardware configurations and related properties.

The information about all these parameters is stored in so called hardware profiles. By selecting a different hardware profile at startup all these parameters are activated. The hardware components and features associated with these hardware profiles are:

- CCD camera selection including frame grabber and configuration file settings.
- All streak devices such as streak camera, spectrograph, and delay generators and its settings like GP-IB addresses.
- All accessory hardware like GP-IB board, counter timer board and its related settings.
- The time calibration related to the streak camera.

Please note: The spectrograph calibration is not part of the hardware profile as it is subject to frequent changes. The spectrograph calibration is stored with other permanent settings like the options and can be saved and recalled by using workfiles.

Saving and loading parameters

Selecting measurement parameters

Saving and loading parameters

This chapter describes how measurement parameters are saved and loaded.

Permanent parameters

Selecting measurement parameters > Saving and loading parameters

Permanent parameters

If the users closes a session and reopens it most of the parameters are remembered permanently and restored once the session is reopened. In other words most of the parameters used in the software are permanent.

There are a few parameters which may confuse the user if they are restored from one session to the next. These parameters are set to a default value when a new session is opened.

To demonstrate this we take the external trigger mode of a CCD camera. The external trigger mode switches the CCD camera to a mode where it only acquires images if a trigger is applied to the camera. We assume that a user which has operated the CCD camera in external trigger mode the day before reopens the session the next day and starts live mode. But due to the fact that the camera is switched to external trigger mode it does not acquire images. It may take long time for the user to remember that he applied triggers to the camera the day before and he may be confused.

Workfiles

Selecting measurement parameters > Saving and loading parameters

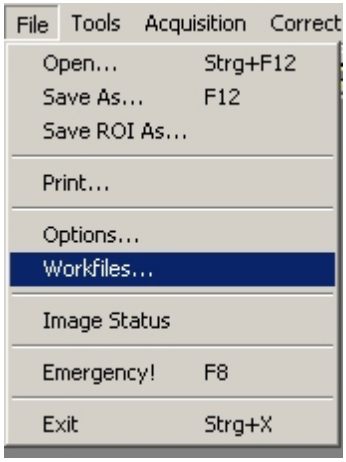
Workfiles

In other cases the user may want to exactly reproduce the experimental conditions he had the day before. In this case he may use the Save/Load workfile feature of the software.

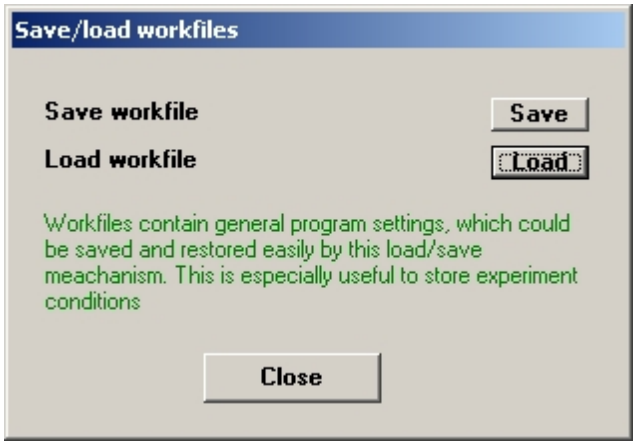
Saving a workfile saves all current parameters (even those which are not permanent in the previously explained sense). Loading a workfile restores all parameters stored previously in this file.

To save the current set of parameters to a workfile proceed as follows:

1) Call the Wokfiles menu command.



- or -
Right click to the programs client area and select Workfiles
The Workfile Dialog appears:



2) Select Save and enter a file name on the file dialog which appears

To Load a Workfile call the Workfile dialog and Select Load.
A warning will be issued saying that all settings will be overwritten by the new settings in the workfile.

Note:

If you are not sure do not load the new parameters

- or -

Save the current settings to another workfile first, and then load the new workfile.

Image positions

Selecting measurement parameters > Saving and loading parameters

Image positions

A special parameter in the general menu defines whether all window positions are restored once the window is opened again. This feature allows the user to tidy up his user interface and to place all dialogs at a location where he is used to search it.

If this option is not checked all windows are loaded to a default position.

Note: If it happens that dialogs are suddenly lost - because they are opened at locations outside of the main dialog -, switching off this feature, closing and reopening the software causes all dialogs to appear at default locations. Any lost dialogs can be found in this way.

Calibration & Analysis

Calibration & Analysis

These topics deals with the calibration of image and profile data and its analysis.

Calibration

Calibration & Analysis

Calibration

Calibration allows to assign physical units to image and profile data. First you can learn what calibration means in this program. Then you get an introduction to the different calibration methods (linear and table type) used in this software. In the topic "System, Image and Profile Calibration" you learn about the hierarchical ordering of calibration. The following chapters show how to make the set-up of calibration for the different methods.

Please see also the Appendix Calibration File Format for details.

What is Calibration?

Calibration & Analysis > Calibration

What is Calibration?

When acquiring images with a two-dimensional camera, light intensities are measured at certain detector elements. These elements are called pixels. Of course there is some spatial relationship (correspondence) between the pixels and the real world. The camera may look into a room with an ordinary objective lens, or it may look at some microscope image, or it may be used as a sensor behind a spectrograph or streak camera. In all cases there is a specific spatial correspondence between the image on the camera and the real world. Calibration is a way to get quantitative information about the real world by extracting data from the camera image.

The geometrical transformations made during calibration process may be simple or more complicated depending on the type of transformation the physical measure undergoes in the complete system:

The simplest (and most often used) way of calibration is to attach a single calibration factor to the system. The pixel distance from one point to the next is then just multiplied by that factor.

The most general way of calibration is to allow a totally free mathematical co-ordinate transformation function like:

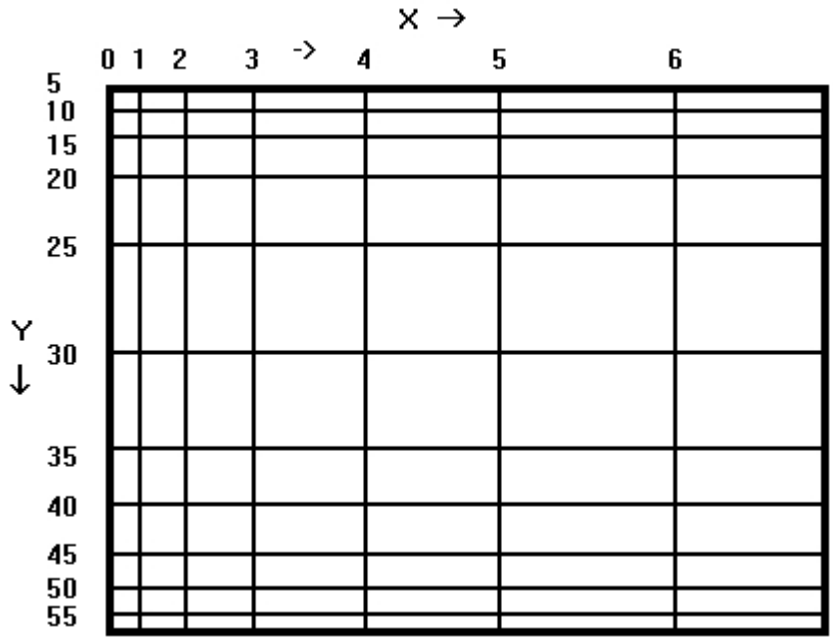
X_scaled =X_scaled (X_camera,Y_camera)

Y_scaled =Y_scaled (X_camera,Y_camera).

Such a very general calibration method, though it is the most versatile one, has three disadvantages:

- To perform such a calibration one would need two two-dimensional calibration arrays of the size of horizontal x vertical pixel number (x 4 byte at least).
- Lines with X_scaled =const or Y_scaled =const are no longer straight, making it very difficult to extract profiles along such lines (what the user typically wants to do).
- It is very complicated to handle this calibration scheme considering how the calibration data could be entered by the user.

Due to practical considerations a calibration scheme has been implemented which is easy to use but versatile enough for most cases. This calibration scheme has the following possibilities and restrictions:



Example image of calibration (non-linear in X and Y direction)

- Lines with X_scaled =constant or Y_scaled =constant always have to be parallel to the camera axes.
- The scales in X and Y can be linear or non-linear. In the latter case they have to be monotonous (increasing or decreasing).
- Non-linear calibration is realised by function tables (called Table Calibration) and any functional relationship can be modeled freely by the user, as long as the "monotony condition" is met.

Linear calibration in both dimensions enables the user to measure data along any arbitrary direction (also non-parallel to the axes).

Linear/Table

Calibration & Analysis > Calibration

Linear/Table

The system calibration contains two sets of calibration data: One for the X axis and one for the Y axis. Each calibration axis can either be of linear or of table type.

The **linear calibration** consists of a calibration factor and a unit. When the unit is the same for both directions and the calibration is linear in both axes, the calibration information can be attached to profiles generated in any arbitrary direction. When the dimension is not the same in both directions or when table calibration is used at least for one axis, only horizontal or vertical profiles can be scaled.

When linear calibration is used the origin for the calibration data of intensity profiles is always the starting point of the profile. The calibration of a profile therefore looks always like:

Pixel No.	Calibration value
0	0
1	1 * Factor
2	2 * Factor
n	n * Factor

Thus, the absolute value will depend on the location of the starting point. If normal images are analyzed this is what the user typically wants. As a consequence, however, if you want to compare two profiles they should start at the same location. If you want to compensate an offset simply change the starting point.

The **table type calibration** consists of a table of **n** floating point values and a unit. **n** corresponds to the number of pixel in the axis. The **n** values reside in a calibration file with the extension **.scl** and are read automatically into memory when needed. The table may contain any values provided that they are strictly monotonous, either increasing or decreasing. (In other words, the function which the table resembles must be invertible.)

If you want to make non-linear calibration or attach absolute values to certain pixels or if you want to create calibration information which does not start at the value zero (e.g. for a spectrograph) you should use table calibration. Table calibration always yields the same scaled value at the same pixel location. Therefore absolute comparison is possible even if the profile windows do not start at the same location.

System / Image / Profile Calibration

Calibration & Analysis > Calibration

System / Image / Profile Calibration

The program distinguishes between the **system calibration**, the **image calibration**, and the calibration for every intensity **profile**.

System, image and all profiles individually can have different calibration information.

The calibration which is assigned to the system is always automatically applied to the current image at the moment the image is acquired. In case a profile is extracted from an image, the current image calibration is applied to the profile. The system passes its calibration to the image, and the image passes its calibration to the profiles.

For this transmission mechanism the following situations may appear:

- The system calibration attaches information to the pixels on the chip (camera). If the image origins on chip and on frame-buffer are not the same, the system calibration must be shifted accordingly.
- If binning is active during image acquisition, the system calibration is modified accordingly. This means, internally a table will be compressed accordingly, and a calibration factor will be multiplied by the binning factor. All these mechanisms are fully automatic and do not require special care from the user.
- When a profile is extracted from the frame-buffer the valid image area is regarded and automatically checked whether the profile sampling window is contained in the valid image area. If not, the user will be prompted to modify the profile sampling window, extend the calibration data linearly or do not assign any calibration information to the profile.

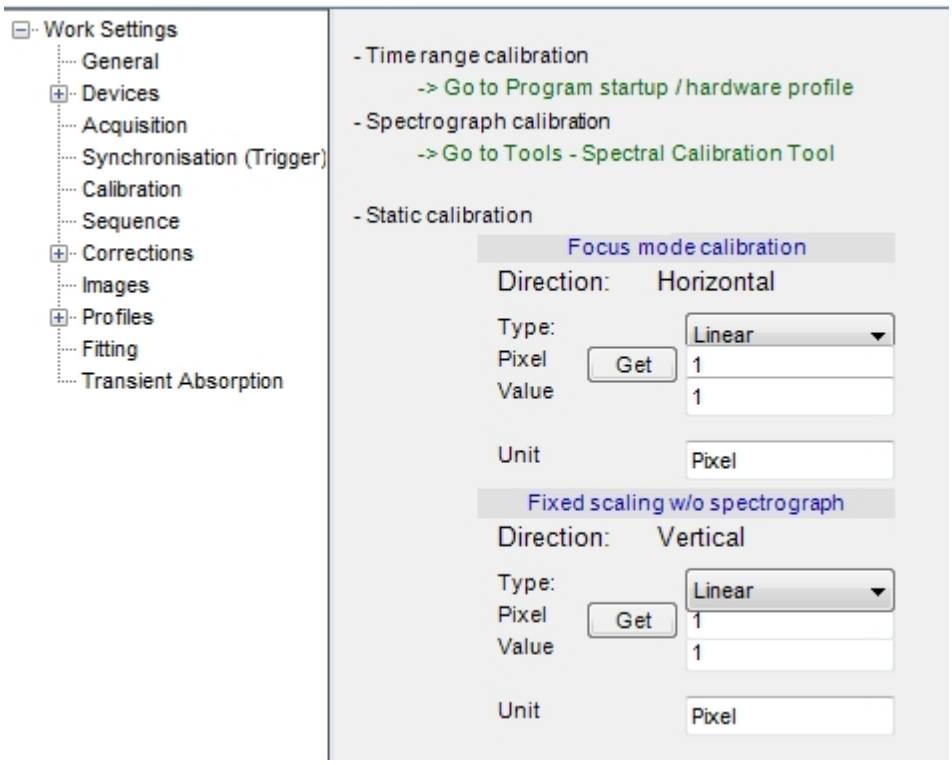
The calibration is always automatically attached to the images and profiles and re-activated when images and profiles are reloaded from disk. In most cases the system calibration can also be reconstructed from the information in the image or profile.

Streak calibration

Calibration & Analysis > Calibration

Streak calibration

The HPD-TA uses a sophisticated automatic method of assigning calibration data to the system.



The calibration setup is done in different parts of the program as is shown by the Calibration Options.

To assign time range calibration do this at program start and select hardware profile then go to the Time Calibration setup.

Note: In most cases this has already been done by a Hamamatsu engineer at installation time, so you do not have to do this normally.

To assign wavelength information use the spectrograph calibration tool.

To assign other physical information in focus mode or perpendicular to the time axis if there is no spectrograph see the chapter focus mode calibration.

Automatic Calibration changes

Calibration & Analysis > Calibration > Streak calibration

Automatic Calibration changes

When the time range in the **streak status/control** box is changed (regardless whether it is changed manually or automatically) the correct calibration for the new time range is enabled automatically. The same is true if the mode changes from **Operate** to **Focus** or vice versa.

Also if the blanking amp is changed in a system with dual time base extender the calibration of this axis is changed automatically.

When the time axis calibration changes an informative message is displayed on bottom of the main window. There it is also displayed whether linear or table calibration is used, which streak camera plug-in model and which time range are selected and which factor or file and which unit are used.

Time calibration

Calibration & Analysis > Calibration > Streak calibration

Time calibration

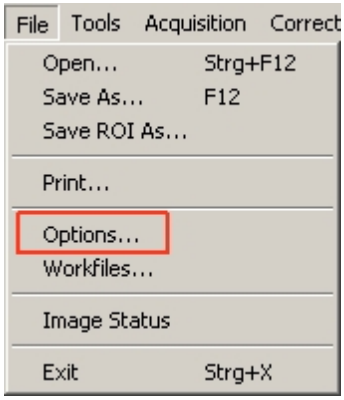
The time calibration is a part of the hardware profile and is only changed when a new hardware profile is selected. Time calibration refers to every axis where a streak sweep is performed. It can be modified by using the time scaling setup.

Focus mode calibration

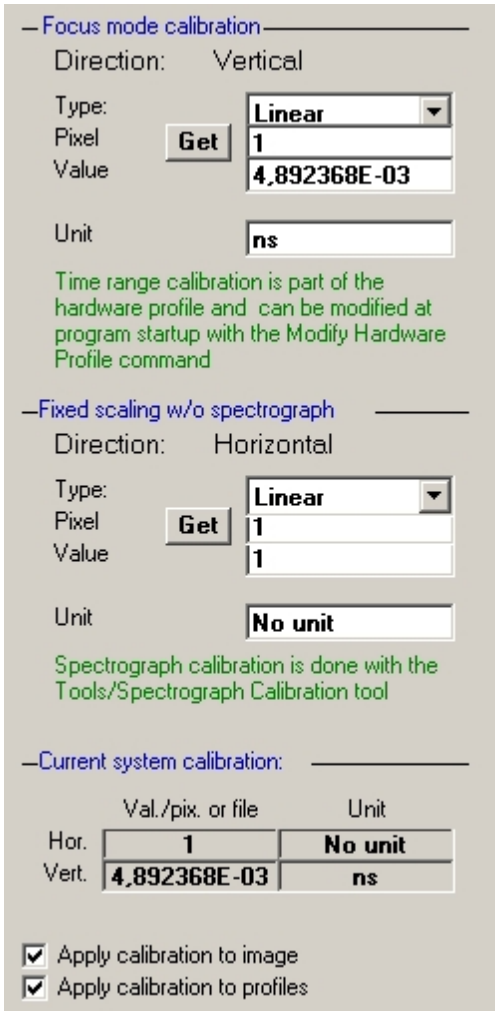
Focus mode calibration

There are two other calibration items which are not assigned to the hardware profile because the user may wish to change them often.

To specify these calibration items, call the Calibration options calling the Options dialog from the menu



and select Calibration within the Tree dialog on the left side.



The First item specifies the calibration which should be active for the axis of the streak sweep (normally vertical) but when no sweep is active. This is always the case in focus mode therefore this calibration is called focus mode calibration.

The second item specifies the calibration perpendicular to the streak sweep but only in the case when no spectrograph is used.

For both items five values can be specified:

Type, **Pixel**, **Value**, **File** and **Unit.**

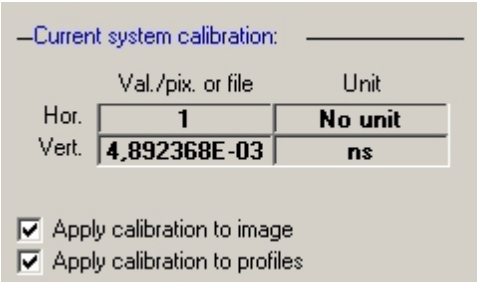
When selecting the linear calibration, the meaning of **Pixel**, **Value** and **Unit** is the same as for square calibration. The only difference to square calibration is that you are specifying the calibration for each axis separately. Hence, for horizontal calibration you specify a horizontal pixel distance and for vertical calibration a vertical distance. For the ease of input you can select a rectangular ROI where either its width or its height is used to calculate the pixel distance depending on the axis direction.

When selecting table calibration **Value** is no longer valid, the entry **File** is valid instead. By pushing the small button **get** on the right side of the **File** entry you can choose a calibration file from a file list.

After you have selected calibration values these are assigned to the system calibration.

The lower part of the calibration dialog informs the user about the current system calibration (the calibration which was active before the calibration options dialog has been called).

You additionally have the choice to assign the new system calibration to the currently selected image and to profiles.



Spectrograph calibration

Calibration & Analysis > Calibration > Streak calibration

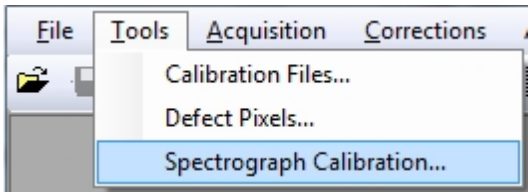
Spectrograph calibration

If a spectrograph is used in the system, the spectrograph calibration is done by the Spectrograph Calibration Tool.

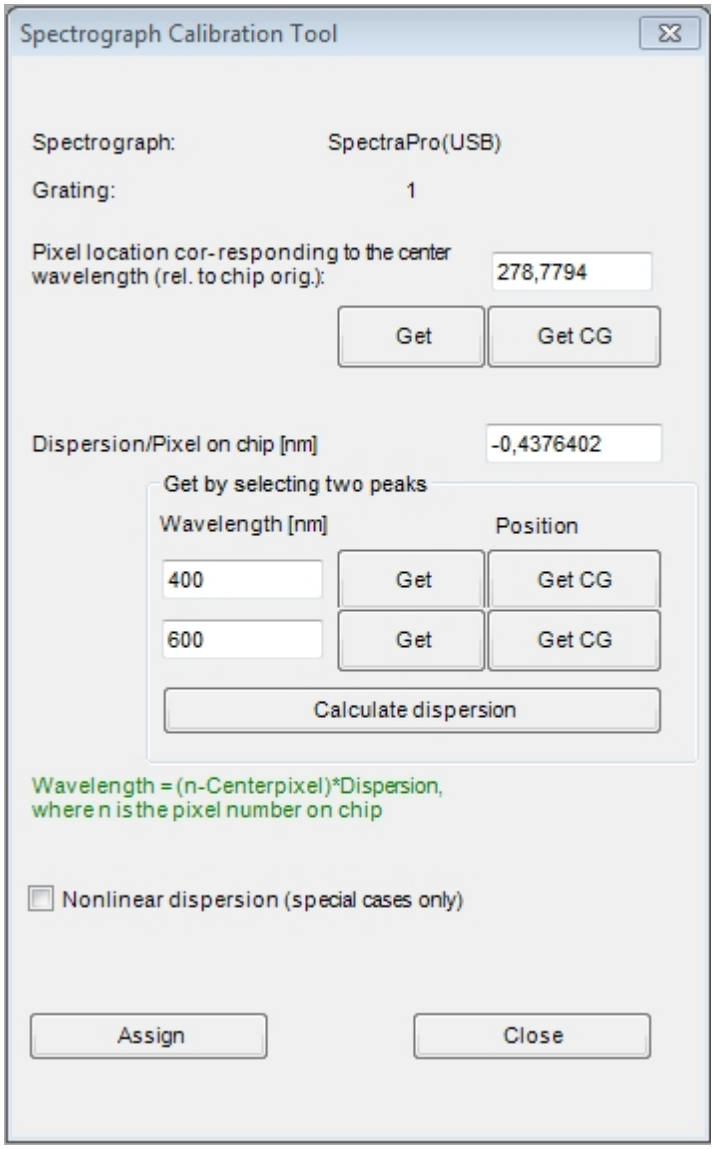
Note: If the imaging device already has a built in spectrograph, such as a mini spectrometer the calibration is done automatically. In this case the Spectrograph Calibration tool cannot be used.

Note: The spectrograph calibration is not part of the hardware profile

To show the Spectrograph Calibration Tool execute the Spectrograph Calibration menu command.



The Spectrograph Calibration Tool will be shown.



The informations displayed in the lines labelled Spectrograph and Grating informs you about the name of the spectrograph and the grating currently used. If you want to make a spectrograph Calibration for a different grating you have to switch to this grating first.

Then you have to specify the dispersion per pixel. These values always refer to "location on chip". This means these values account for binning, subarray etc.

Please proceed as follows to make the set-up for spectrograph calibration:

- Use a light source of known wavelength.
- Set the center wavelength of the spectrograph to this wavelength.
- Take an image (in any acquisition mode, may be Live mode) and you will see the corresponding peak somewhere on the screen (Due to slight misalignment it may happen that this peak is not exactly in the center.).
- Move the cross-hair cursor in the image to the peak and press **Get** located on the right side of the entry **Pixel location corresponding to the center wavelength (rel. to chip orig.)**. The correct value will appear on the left side of this push-button.
- If you want to define the pixel position by a center of gravity calculation, define a rectangle ROI at the area where the peak is and press Get CG. For best result the image should be background subtracted.

- Select a center wavelength on the spectrograph where you can see two known peaks.
- Enter the wavelengths of the two peaks in the text boxes **Wavelength** and define the pixel positions of both wavelengths same as above by selecting a single pixel and press Get or by selecting a ROI and press Get CG.
- When this is done press the push-button **Set** and a value for **Dispersion/pixel [nm]** will be calculated and displayed in the corresponding text box.
- If all these values are correct press **Assign Calibration** to assign the calibration to the specified grating.

When the center wavelength or the grating is now changed with the **status/control** box for the spectrograph the system calibration for the axis perpendicular to the streak axis is automatically updated. This calibration is linear with a fixed dispersion having the center wavelength automatically at the location previously defined by **Pixel location corresponding to the center wavelength (rel. to chip orig.)**

Note:

The option use 2nd order calibration is provided for very special cases where the dispersion is not constant when changing the center wavelength.

In such cases the dispersion is still constant across the window but changes if the center wavelength is changed according to the following formula:

```
Wavelength = (n-Centerpixel)*Disp,
where n is the pixel number on chip.
Disp = (Dispersion0 + CenterWavelength * Dispersion1)
```

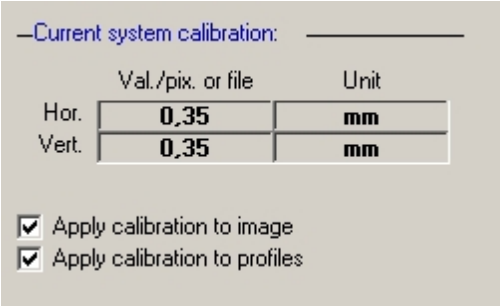
System Calibration

Calibration & Analysis > Calibration > Using Different Calibration Methods

System Calibration

The lower part of the calibration dialog informs the user about the current system calibration (the calibration which was active before the calibration options dialog has been called).

After you have selected calibration values these are assigned to the system calibration. You additionally have the choice to assign these values to the currently selected image and to profiles.



Profiles

Calibration & Analysis

Profiles

A profile is a one-dimensional data extracted from an image. This chapter shows which kind of profiles HPD-TA can handle and how to deal with them.

Quick profiles

Quick profiles

The easiest way of extraction profiles is to use the quick profile feature where profiles extracted from horizontal or vertical Region of interests (ROIs) are displayed on the same window than image.

Analysis profiles

Analysis profiles

Profile Analysis extracts one-dimensional intensity data from the image along user-defined positions, attaches scaling information and calculates and displays various information about these data.

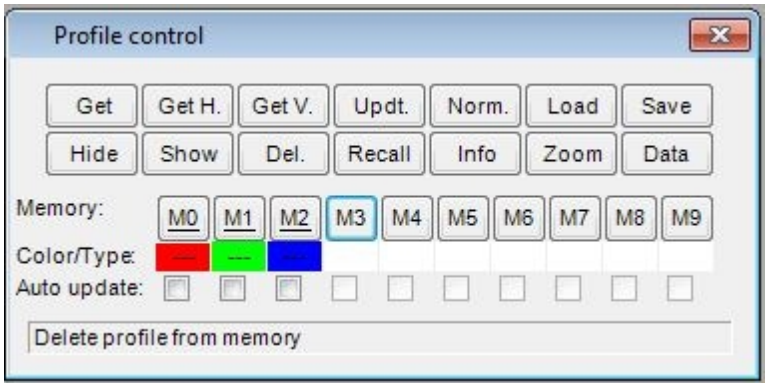
In the following eight sections you learn how to use the profile analysis tools. First you get general information about the profile tools, followed by a detailed description of the profile control and profile display window. Then you learn how to acquire and display profiles, how to attach scaling to the profiles and how to make a more detailed analysis. Finally you get information about how to handle profile data and how to export them to other programs.

Please see also the appendix Profile File Format for details.

General Information on Profile Analysis

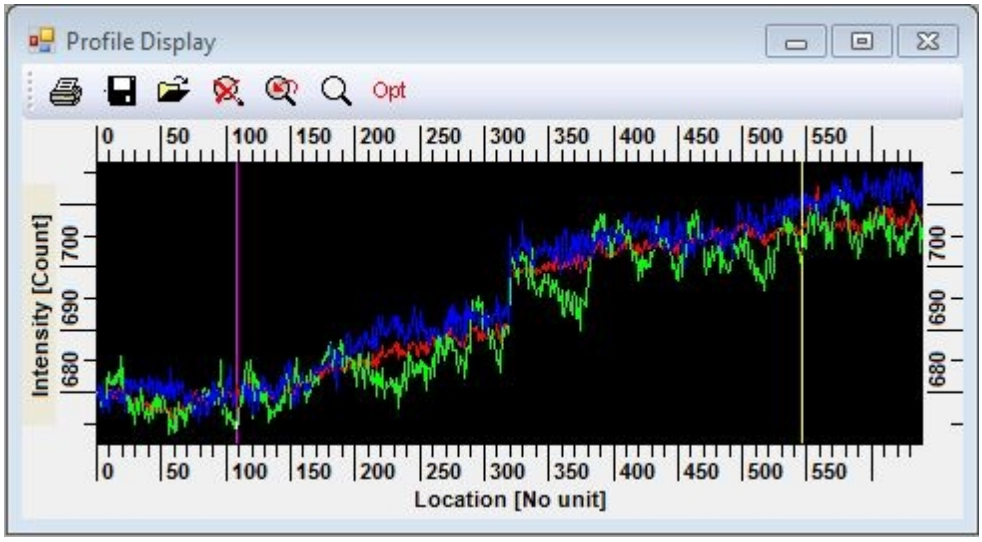
General Information on Profile Analysis

Choose **Profile** from the **Analysis** menu to display the Profile Control and the Profile Display dialogue boxes or toggle the state of the profile button on the toolbar.



Profile control dialogue box

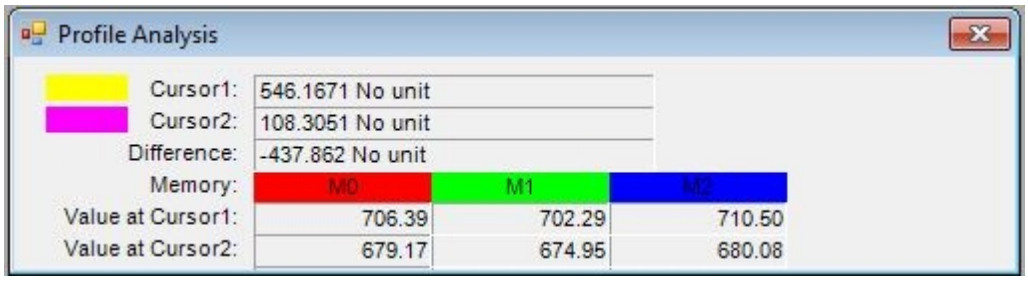
The **Profile Control** dialogue box offers a variety of controls to acquire, display and handle profiles.



Profile display dialogue box

The **Profile Display** window is used to display the profiles. It can be freely resized by the user. A toolbar on top of the **Profile Display** dialogue box offers a variety of display and analysis options.

When the option **Analysis** on the **Profile Display** dialogue box is selected, the **Profile Analysis** dialogue box appears on the screen in its standard size.



Standard type of the profile analysis dialogue box

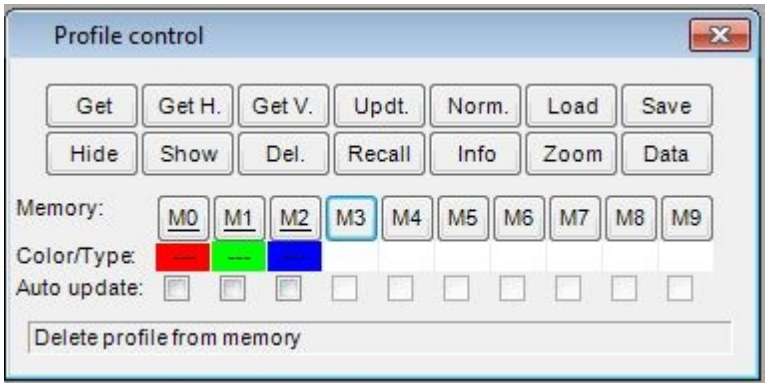
If the option **Detailed analysis** is additionally selected the **Profile Analysis** dialogue box becomes larger and displays several additional analytical data.

The Profile Control

Calibration & Analysis > Profiles > Analysis profiles

The Profile Control

The **Profile Control** dialogue box is designed in the sense that you first select the desired action (command button) and then the desired memory the action should work on. The last command remains active unless another command button is pressed. For example if you want to delete several profiles it is sufficient to click the **Del** push-button once and then the memory buttons whose profiles you want to delete.



Profile control dialogue box

The **Profile Control** window contains the following parts:

- A series of command buttons on the top of the window.
- 10 memory buttons
- 10 small fields below the memory buttons displaying the color and the type of the profile (these fields are invisible if the memory is empty)
- 10 check boxes to specify the **Auto update** function

A text box displaying messages such as a brief description of the currently selected command or an error message

The command buttons activate the following commands:

Get	Acquires a profile with arbitrary starting and ending points (requires a line ROI)
GetH	Acquires a horizontal integrated profile (requires a rectangular ROI)
GetV	Acquires a vertical integrated profile (requires a rectangular ROI)
Updt	Updates the profile from the current image (at the same position and direction).
Norm.	Normalizes all other profiles to the maximum height of the selected memory. This allows to compare profiles which differs strongly in intensity.
Load	Loads a profile from disk into memory. If the profile is a part of a profile sequence the sequence will be loaded starting with the file you selected
Save	Saves a profile from memory to disk. If the profile is acquired from an image sequence, profile data for all images of the sequence will be saved.
Hide	Hides a profile. It disappears from the **Profile Display** window.
Show	Shows a profile which previously has been hidden.
Del.	Deletes a profile from memory (Caution: this command is irreversible).
Recall	Shows the profile sampling window on the current image and displays its co-ordinates in pixels and scaled units in the message field. The selected ROI becomes the current ROI. Its parameter can be changed now (e.g. using the ROI info tool).
Info	Shows the **Profile Info** window, which contains the full information about the profile and the parent image
Zoom	Adjusts the scale of the **Profile Display** window so that the selected profile will best fit into it.
Data	Displays the content of a profile memory in a text box.

Acquiring Profiles

Acquiring Profiles

There are three types of profiles: **Line** profiles, **Integrated Horizontal** profiles and **Integrated Vertical** profiles.

Before you acquire profiles, you may want to assign scales to the X-and Y-axis of the image.

To select any type of profile you first have to select an appropriate ROI. If more than one ROI is selected for an image all profile actions always refer to the currently selected ROI (this is the one which is displayed with a dashed line).

When you want to get a **Line** profile select a line-type ROI  . Press **Get** and the memory

button where you want to store the profile. The profile values are sampled along the specified line with a step width of one pixel thus preserving the assigned scaling in case of linear scaling.

Integrated Horizontal profiles and **Integrated Vertical** profiles are sampled along the sensor axis either horizontally or vertically.

When you want to get an **integrated** profile select a rectangular ROI (Any of the three selections , , or). To get either of both profile types press the **GetH** or **GetV** command button and click to the memory button where to store the profile. Depending on the type of profile (horizontal or vertical) a profile is extracted from the image within the specified window. The pixel intensities are averaged (integrated and normalized by the sampling window width) along the direction perpendicular to the profile direction. Since the values are averaged they will be independent of the width of the profile sampling window and fractional pixel intensities may occur with integrated profiles.

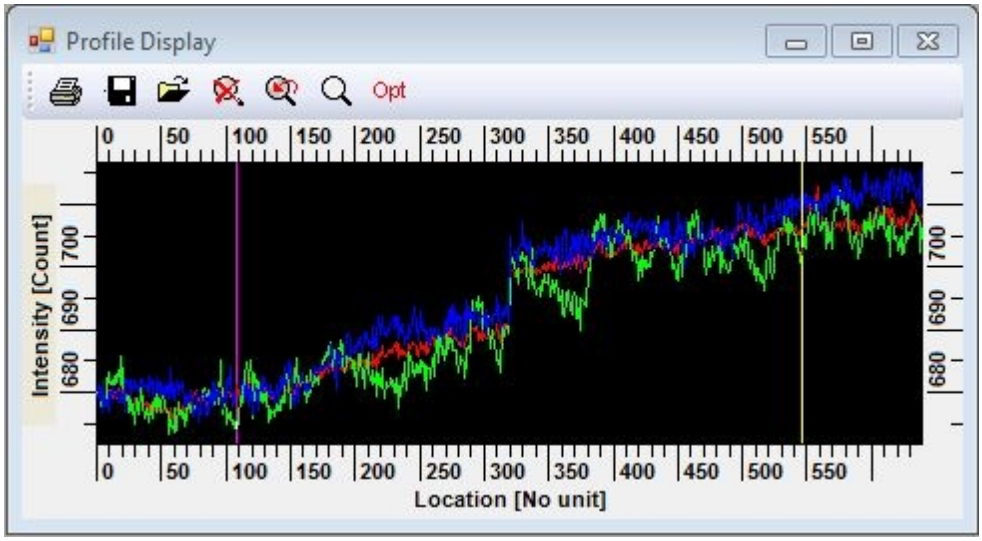
When there is already a profile in the specified memory the previously selected profile sampling window is displayed as default. If you select the **Updt** command you automatically get the same profile type as it has been in the memory before with the previously selected profile sampling window, but the data are re-calculated from the current image (which may have changed).

When the **Auto update** checkbox is clicked for an already existing profile the profile is automatically updated when the image data have changed. This function is triggered for example by image acquisition, by dark subtraction, by loading an image from disk, and so on. This checkbox has to be clicked if the profile shall be saved during profile sequence acquisition.

Displaying Profiles

Displaying Profiles

The **Profile Display** window is used for displaying the extracted profiles.



Profile display window

The full area of the **Profile Display** window is used to display the profiles. Several profiles can be displayed at a time, provided that the scaling unit is the same. (The scaling may be different, but the unit must be the same.) Hence it is possible to simultaneously display profiles which were derived from different images, even with different scaling.

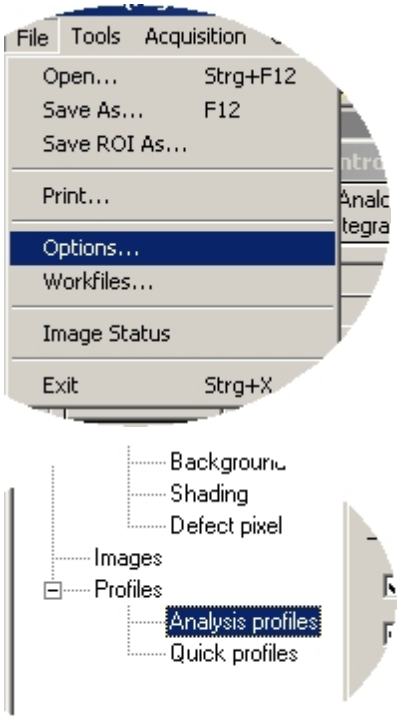
*Note: The system is not able to compare profiles with the same physical dimensions but with different units like **mm** and **cm** or **m.***

Above the profile display you will find a task bar with functions to save and load ROI sets, to

print profiles and to set some preferences.

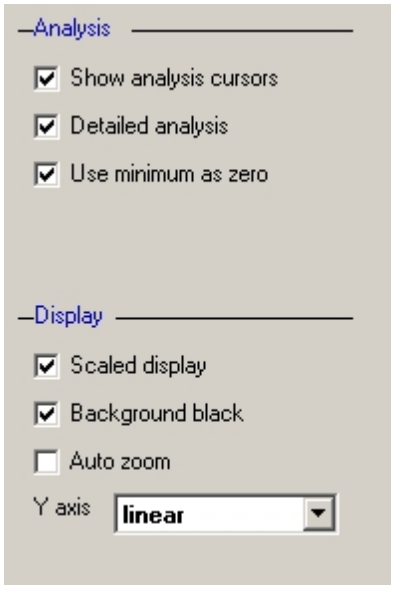
	Print Profile	Prints the profile display window on your printer
	Save ROI	Save the actual set of ROIs
	Load ROI	Load a previously saved set of ROIs
	Unzoom	Zooms out completely. (Then the intrinsic limits will determine the zoom ranges).
	Zoom last	Restores the last zoom setting. This is useful is you have zoomed too deeply into a profile and you want to get back one step. **Note**: By using this command repeatedly you can alternate between two defined zoom settings.
	Zoom all	Optimizes the zoom factor to display all actual profiles in a maximum size
Opt	Options	Opens a dialogue box to set profile display options

To Open the Profile options either call the options menu and select the Analysis Profile item on the tree control



or right click to any of the profile dialog windows.

The Analysis Profile dialog will appear.



Profile options

In the profile display options dialogue you can set following parameter:

When **Analysis** is selected, two cursors appear on the **Profile Display** Window and the **Profile Analysis** window appears on the screen.

The option **Detailed Analysis** and **Use Minimum as zero** are explained in the chapter Profile Analysis.

When **Scaled Display** is active, the scaling data attached to the profile is used to get the correct physical value for every data point. If **Scaled display** is inactive corresponding pixel values are displayed. With this option you can even display profiles with different units. All analysis values are displayed in scaled values or in pixels according to this option.

There are three different possibilities for display of the intensity axis. It can be either displayed linear or logarithmic with the base 10 or with the base e. This can be selected by choosing one of the options **Linear, Log(base e)** or **Log(base 10).**

Background black determines whether the profile background will be displayed black or white.

If **Auto zoom** is selected, the system performs a zoom operation whenever a profile has been changed. This ensures that always the best display mode is selected to show all actual profiles within the display window with maximum size (like the Zoom all button).

By using the mouse you can interactively **zoom** into a portion of the profile as follows:

- Move the mouse cursor to one of the corners which define the area you want to zoom in.
- Press the **right** mouse down.
- Move the mouse to the opposite corner of the area you want to zoom in.
- Release the mouse button.

You can repeat this process as often as you like.

Every profile has its intrinsic **data limits**. These are defined by the first and last data point in the X direction and by the data type and the detailed circumstances of the exposure in the intensity direction. When the **Unzoom** function is executed these intrinsic limits are used to define the zoom ranges. If more than one profile is displayed the absolute maximum and minimum values of the intrinsic limits of all these profiles are determined. The intrinsic limits for different type of data are as follows:

If a memory contains a profile the "Mn" text on the push-button is underlined. In addition, the type of profile can be determined by the small symbol below the button.

****	is displayed for line profiles,
---	for integrated horizontal profiles and
|	for integrated vertical profiles.
s	profile sequence
f	profile file
j	result of jitter correction
a	averaged profile

If a memory contains a profile which is not hidden then the background color under the symbol is the same as the profile's color. If it is hidden, that color is white.

You can temporarily hide a profile by clicking the **Hide** button in the Profile control dialogue box. But the system may also hide a profile automatically. This happens if you display a scaled profile with a unit different to that of other profiles in the display. In this case, the other profiles will be hidden (until you **show** them again).

When selecting **Print Profile**  from the **Profile Display** window the systems sends a hard-copy of the current **Profile Display** window to the Windows printer currently installed.

Profile Scaling

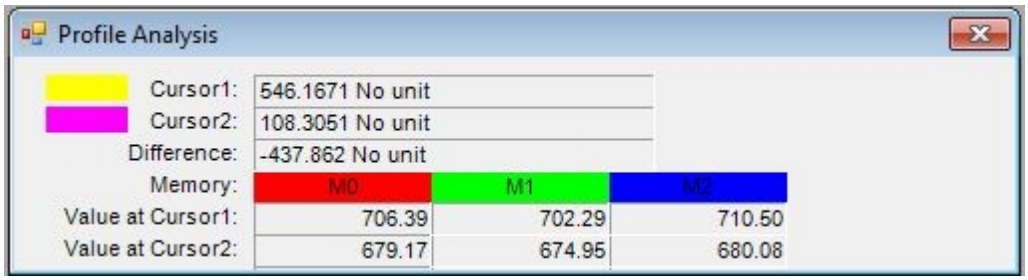
Profile Scaling

In the moment a profile is generated the scaling information is transferred from the image to the profile. If the scaling of x and y direction is incompatible (different unit or table scaling) the scaling cannot be transferred to a profile with arbitrary direction.

Profile Analysis

Profile Analysis

When **Analysis** from the **Option** menu of the Profile Display window is selected, the **Profile Analysis** window will appear on the screen in its standard size and two cursor will appear within the **Profile Display** window.



Profile analysis window

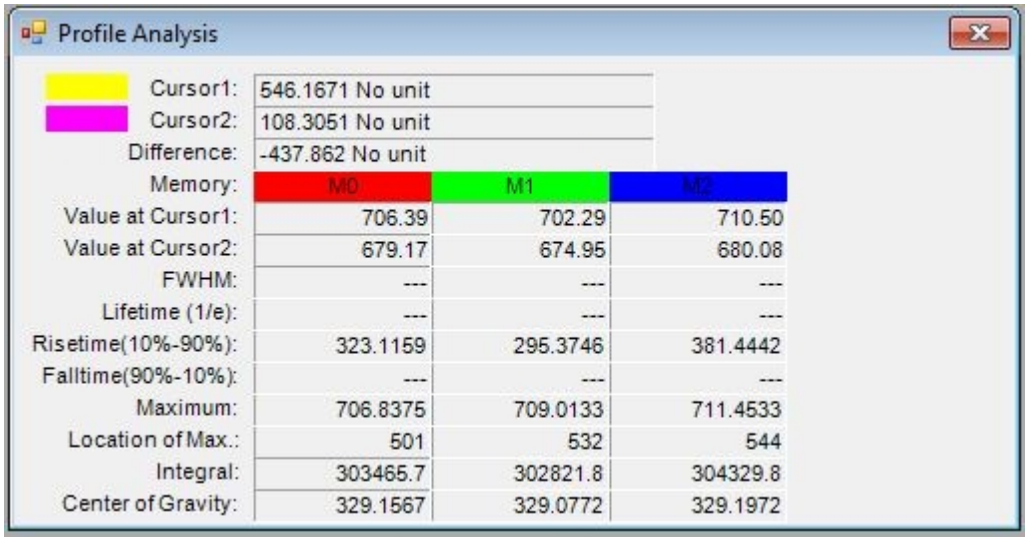
You can move the cursors by clicking and dragging them with the left mouse button (like the cursors on the LUT tool). The profile analysis display shows the X-values (pixel numbers or scaled values) and the difference between the two cursors. This is useful for measuring distances. It also shows the intensity values of all profiles at the cursors locations. If the cursor is out of the range of a profile the strings "out>" or "<out" will appear instead of a number.

Note that the movement of the cursors is not bound to the profile channels. If you move them between two channels an interpolated value between the two neighbor channels will be used. The colors of the profiles are displayed in the text box showing the memory numbers.

This Profile Analysis window can show the intensity values of all memories at one time (up to 10 memory buffers). If more memories are going to obtain profiles the width of the window will increase automatically.

When **Scaled Display** is selected under the **Options** menu all values are scaled values, otherwise all displayed values are pixel values. During movement of the cursors the values **Cursor1, Cursor2, Difference, Value at cursor1** and **Value at cursor2** are updated continuously.

If the **Detailed analysis** is selected under the **Options** menu several additional numerical values will be displayed.

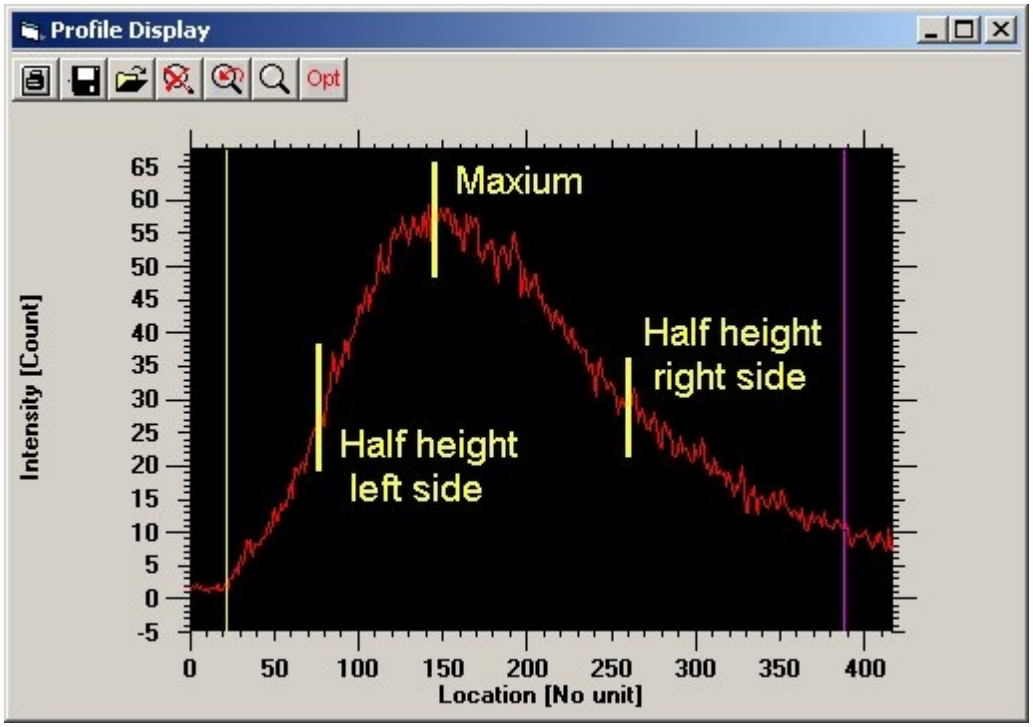


Memory:	M0	M1	M2
Value at Cursor1:	706.39	702.29	710.50
Value at Cursor2:	679.17	674.95	680.08
FWHM:	---	---	---
Lifetime (1/e):	---	---	---
Risetime(10%-90%):	323.1159	295.3746	381.4442
Falltime(90%-10%):	---	---	---
Maximum:	706.8375	709.0133	711.4533
Location of Max.:	501	532	544
Integral:	303465.7	302821.8	304329.8
Center of Gravity:	329.1567	329.0772	329.1972

Profile analysis window (extended type)

The profiles are analyzed in the region between the two cursors and the values for **FWHM** (full width at half maximum), **Lifetime**, **Risetime**, **Falltime**, **Maximum**, **Location of Max.**, **Integral** and **Center of Gravity**. These values are updated when the cursor is placed at a certain location and the mouse is released. They are not continuously updated during mouse movement.

All these analysis functions first search for the absolute maximum in the interval between the two cursors.



Data which are analyzed from an intensity profile

It does not matter whether cursor 1 is at the right side of cursor 2 or vice versa. The region for the analysis is always extended to the next measuring point. (This may be important to know when the selected area is very small.) After the absolute maximum has been found, the profile is scanned until its value becomes smaller or equal to a certain value. (For example, for the FWHM this value is just half the value of the maximum.) When the value lays between two data values a linear interpolation is made to find an estimation for the correct value.

For some functions the "zero point" has to be determined. By default this point is exactly at intensity =0. However, if the option **Use Minimum as zero** under the **Options** menu is selected the minimum found in the region between the two cursors is regarded as the zero point. This is very useful if the profile contains an undesired offset.

The values are calculated as follows:

Value	Search starts at	Direction	Search value	Search value if "Use Minimum as zero"
FWHM right	Maximum	to right	(Max)/2	(Max+Min)/2
FWHM left	Maximum	to left	(Max)/2	(Max+Min)/2
Lifetime top	=Maximum			
Lifetime right	Maximum	to right	Max/exp(1)	(Max-Min)/exp(1)+Min
Risetime 10%	Maximum	to left	Max*0.1	(Max-Min)*0.1+Min
Risetime 90%	Maximum	to left	Max*0.9	(Max-Min)*0.9+Min
Falltime 90%	Maximum	to right	Max*0.9	(Max-Min)*0.9+Min
Falltime 10%	Maximum	to right	Max*0.1	(Max-Min)*0.1+Min

FWHM=FWHM right-FWHM left

Lifetime=Lifetime right-Lifetime top

Risetime=Risetime 90%-Risetime 10%

Falltime=Falltime 10%-Falltime 90%

Note: The purpose of these simple analysis functions is to get fast information about the profile characteristics. The usefulness for precise analysis, however, is limited.

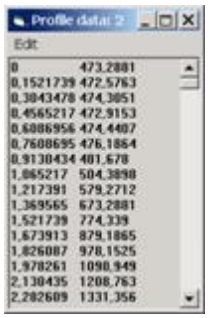
Integral calculates the integral (area under the profile) between the two cursors. (This can e.g. be used to calculate pulse energies).

Center of Gravity calculates the center of gravity of the profile between the two cursors. This can be used to calculate the position of a relatively broad pulse with greater precision than the Peak function.

This fast analysis cannot replace a thorough data analysis which is often necessary. Especially the fast analysis tends to be quite sensitive to noise. A thorough analysis would often require treatments like Fourier analysis, filtering, curve fitting, etc. which are out of scope of the functions built into the HPD-TA.We recommend to use specialized software for those higher requirements.

Displaying Profile Data

Displaying Profile Data



Profile display text box

When the **Data** command is selected on the **Profile Control** dialogue box the content of the profile data is displayed in a text box **Profile X Data** where X stands for the number of the profile (e.g. Profile 0 Data).

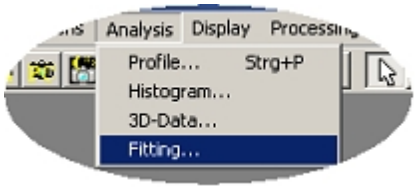
The data contains two entries for each data point (X and Y) separated by a TAB character. The data points are separated by CR+LF characters. X is the assigned scaling value and Y the intensity value.

Fitting

Calibration & Analysis

Fitting

Fitting is an option of the HPD-TA. It is only available if the hardware lock contains a key to unlock this option. To start a Fitting session execute the Analyze - Fitting Menu command.



If this command is not available, your hardware lock may not contain the license for the option.

Please see the Fitting manual for details of the operation.

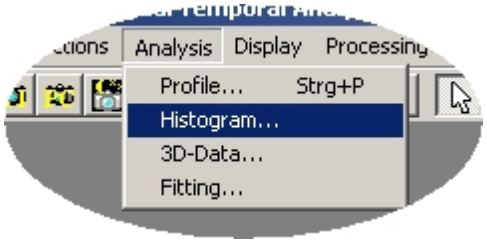
Histogram

Calibration & Analysis

Histogram

Histogram analysis is a statistical analysis of intensity data within an user-defined area of interest

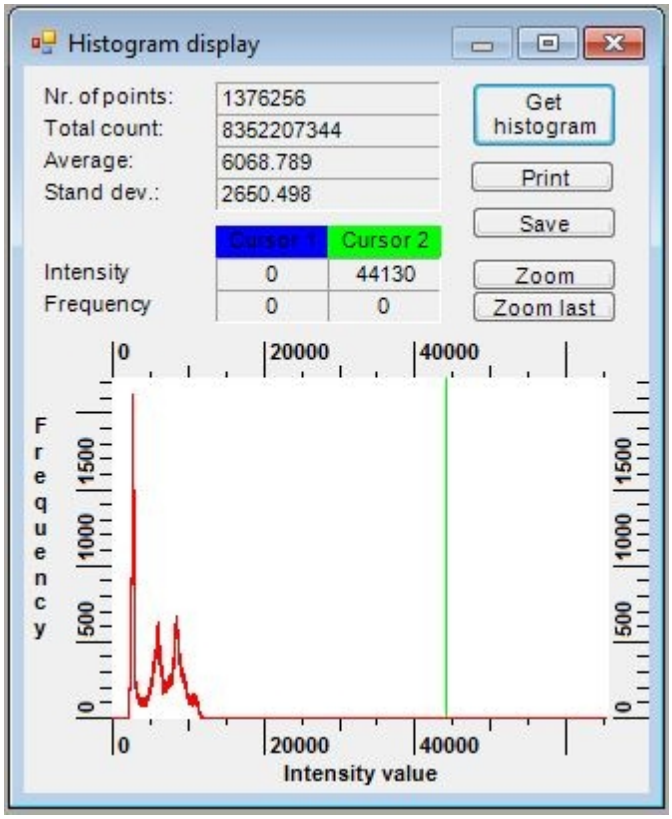
Choose **Histogram** from the **Analysis** menu to display the Histogram window.



Select a rectangular Area of Interest) If no ROI is defined, the histogram will be calculated from the whole image area.

Click **Get Histogram** to get the intensity histogram.

The histogram window displays the calculated histogram. By clicking the right mouse button and moving the mouse into the histogram display a cursor will appear. You can see some statistical data for the selected intensity like how often this intensity value appears in the specified region (**Total Count**), average intensity value (**Average**)or standard deviation (**Stand. Dev**.). These data may sometimes be useful for signal characterization (e.g. noise characterization). Move the cursor to inspect the data of other intensity values.



Histogram window

Click **Print** to print the intensity display.

Click **Save** to save the histogram data to a text file.

A portion of the histogram can be displayed by zooming with the right mouse button. Clicking to zoom displays the whole histogram correctly. Zoom last restores the last zoom window.

Note: Due to technical reasons 32 bit image data can be analyzed by the Histogram function only with reduced accuracy.

3D Data

Calibration & Analysis

3D Data

This function allows to display numerical intensity data from within a user- defined area of interest.

Note: This function is rather limited. Since version 9.4 a bird view display can be used to display data in a 3-dimensional way.

Extract 3D Data from an Image

Calibration & Analysis > 3D Data

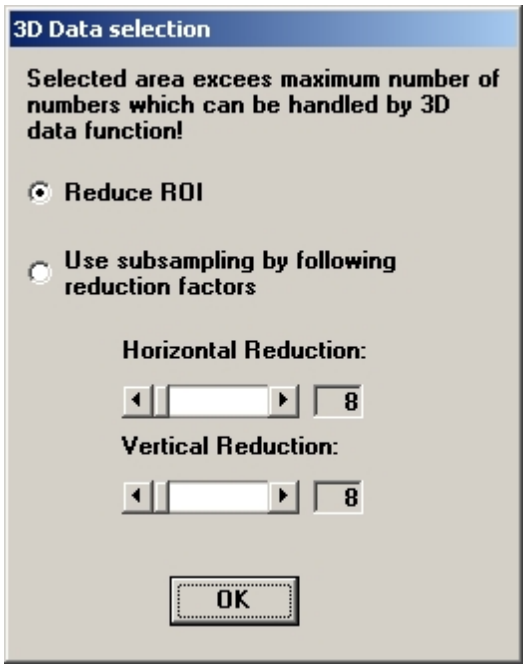
Extract 3D Data from an Image

The image data is displayed in a text box by this function. As the maximum number of characters in a text box is 32000 normally not all pixels values can be displayed. Therefore only every n^{th} Pixel value is displayed. n is determined by the size of the area to display or the area will be modified.

To extract 3D Data from an image proceed as follows:

1. Select a rectangle ROI within you image
2. Choose **3D Data** from the **Analysis** menu.

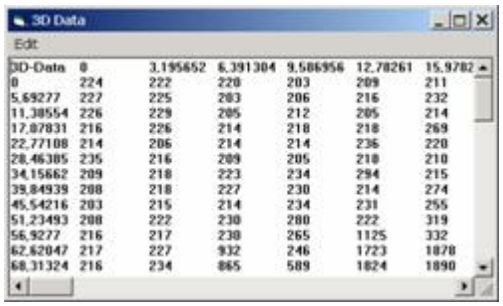
3. If the Area is larger than the amount of data which can be displayed in the text box the user is prompted to select the area from where to extract the 3D data. According to the size of the area one has to select the factor n for every direction from the 3D data selection dialogue box. Alternatively the user can select whether he wants the software to automatically reduce the ROI while keeping the center point of this ROI.



3D data selection dialogue

4. The minimum values for the horizontal and vertical reduction (means maximum amount of data) are predefined. If one wants to select less data points one has to increase the values for horizontal and vertical reduction. After you click OK the 3D Data will be extracted from the current image and its numerical values will be displayed in the 3D Data dialogue box.

The pixels values of one line are separated by TAB characters. Different lines are separated by CR+LF characters. The first line contains scaling information in the X direction. The first column contains scaling information in the Y direction.



3D Data dialogue box

Note: An alternative method to get image data in Text-Format is to save images in ASCII format. With this format the full image can be saved but the amount of data will be rather high.

Sequence acquisition

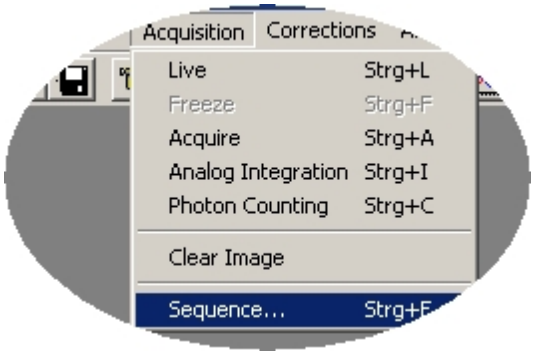
Sequence acquisition

In sequence acquisition mode a series of images and/or profiles can be acquired. Dependent on the settings the sequence is recorded to the computer RAM (fast method, but length of recording is limited by RAM size) or to hard disk. The sequence function can save and load sequences and replay the sequence. Also sequences of intensity profiles can be recorded.

Note: At any time only **one** sequence can be active (either image or profile sequence).

There are three different ways (RAM, HD one file per image, HD one single streaming file) of storing sequence images. Depending on the complexity of image acquisition not all three ways of storing are available.

Sequence operation is controlled from the sequence dialog. To call the sequence dialog execute the Sequence menu.



The sequence dialog will appear.

The sequence acquisition dialog has three tabs where different types of parameters can be specified

Acquisition	Defines which and how images acquire and in which timing this should be done.
Data Storage	Defines which types of data should be saved (images and/or

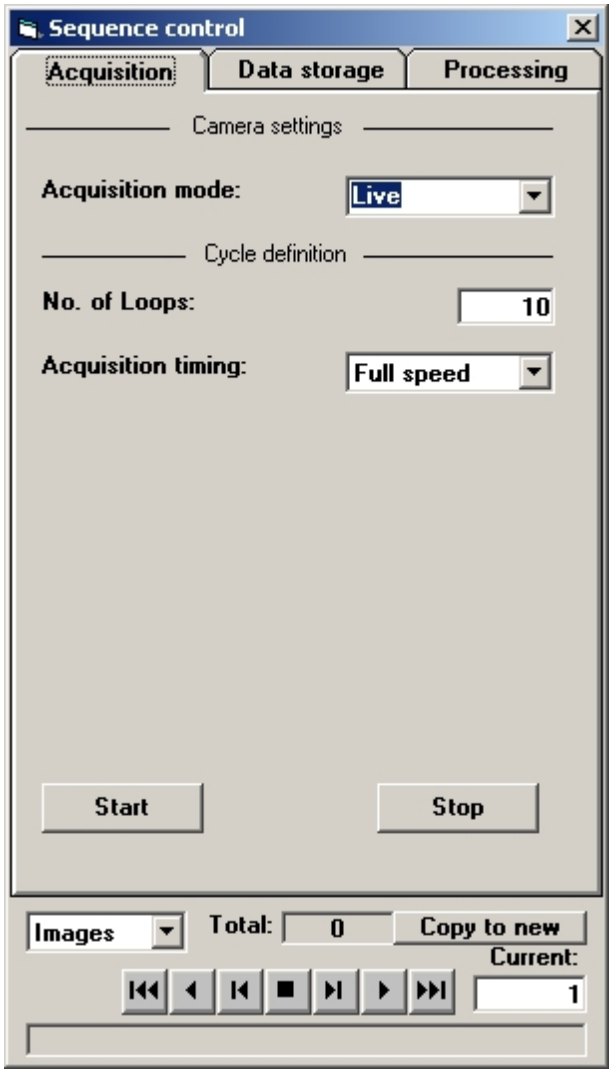
	profiles) and how and where these should be stored
Processing	Allows to process the collected sequence data (average)

Selecting acquisition parameters

Sequence acquisition

Selecting acquisition parameters

To specify the acquisition parameters select the Acquisition tab.

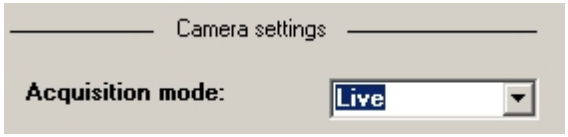


Acquisition mode and camera parameters

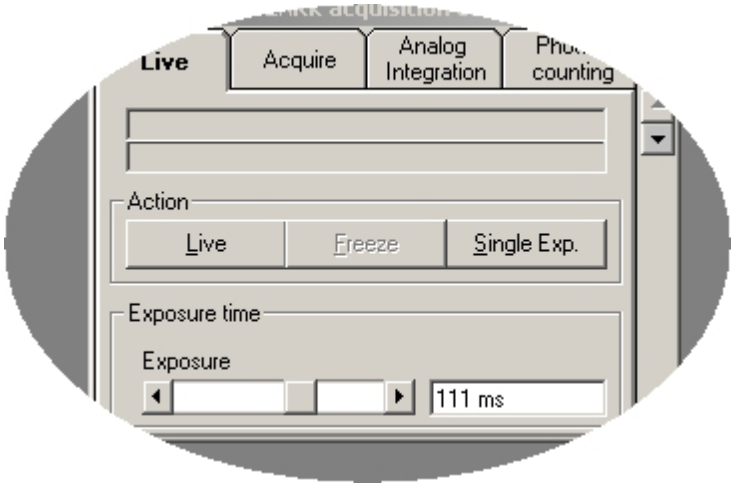
Sequence acquisition > Selecting acquisition parameters

Acquisition mode and camera parameters

The first thing to specify is in which acquisition mode the image data is acquired.



Images are acquired with the acquisition parameters specified in the camera acquisition dialog with the parameters specified in the corresponding tab:



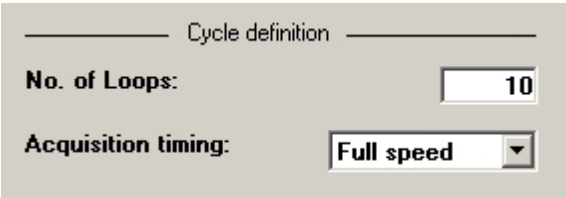
Also the camera parameters specified in the camera options are valid for the selected acquisition.

Cycle definition

Sequence acquisition > Selecting acquisition parameters

Cycle definition

The next things to specify are the properties of the cycle. The user has to specify how many loops he wants to perform and whether this should take place with full speed or predefined fixed interval.



No. of loops specifies how many images are acquired and stored.

Choices of Acquisition timing are **Full speed** or **Fixed intervals**. If you select **Full speed** the camera is running freely and the sequence is recorded with this timing. Immediately after the acquisition and storage of an image the next acquisition will be executed. The time interval is just defined by the exposure time, the readout time, the response time of the mechanical shutter and the data storage time.

Note: Fast hard disk recording works with **Live** mode and **Full speed** setting only.

If you select **Fixed intervals** you can define the interval from one acquisition to the next (examples of allowed formats: 500ms, 2.5s, 1m). This interval should of course be larger than the time needed for acquisition, readout and data storage.

Other information on the acquisition tab

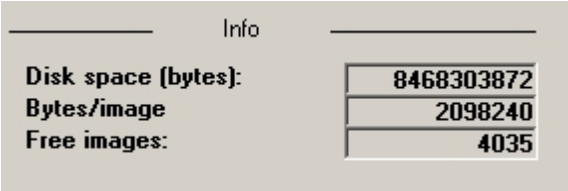
Sequence acquisition > Selecting acquisition parameters

Other information on the acquisition tab

Depending on the data storage the program may display other information on the acquisition

tab.

These may be information about remaining disk space if saving to HD



In the case fast hard disk recording is used the available buffers during acquisition is displayed and if there were lost frames due to limited performance. If streaming engine is used for fast hard disk recording buffers for the hard disk recording are also used and the available number is displayed,

In the case of long interval time and if the options Warning on is selected in the sequence options the remaining time to the next acquisition is displayed.

Start sequence acquisition

Sequence acquisition > Selecting acquisition parameters

Start sequence acquisition

If all parameter are selected clicking to start starts the sequence acquisition process.

The precise behavior of this process is defined be several parameters in the sequence options.

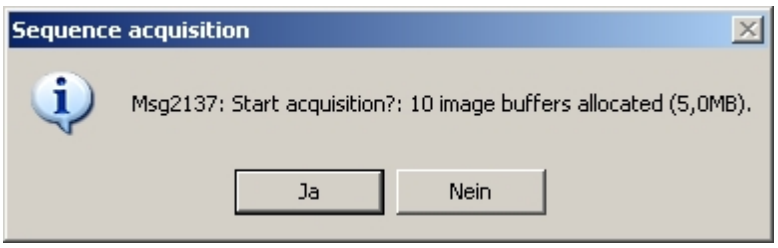
Prompt before start

Sequence acquisition > Selecting acquisition parameters > Start sequence acquisition

Prompt before start

One option defines whether the sequence option should start immediately after the Start button is pressed or not.

If this option is selected the software shows a dialog and does not start until the User Clicks to OK

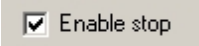


This feature can be used to precisely start the sequence.

Enable stop

Enable stop

Set **Enable stop** in the sequence options in order to enable the possibility to stop the image acquisition at a desired time.



On older computers this function may sometimes slow down the sequence acquisition a little bit. This option should be selected normally. Only in cases where cameras with very high frame rate are used it may be an advantage to deselect this option.

Wrap around

Wrap around

A sequence acquisition to RAM offers the possibility to use the specified number of images as a ring buffer. Once the last image has been reached it restarts from the first image overwriting older images by newer one. To activate this option the user has to select Enable wrap around in Acquire to Ram mode in the sequence options dialog

Then a checkbox at the acquisition tab will appear.

If the user selects this option the sequence acquisition will restart automatically once it has reached the end of the buffer. In this measurement mode the sequence acquisition does not end until the user stops the acquisition with the Stop button. The most recent acquired images are kept after stopping the acquisition.

Note: This option is only effective if the images are acquired to RAM.

Display during acquisition

Display during acquisition

Normally all sequence images are displayed during acquisition. Sometimes the frame rate is so high that the image acquisition is slowed down just because of the image display. In such case the option Always display image during acquisition in the sequence options should be switched off.

Sometimes the image display speed can be influenced by the image zoom factor. Many graphics boards have the feature that image display with zoom 1 is faster than image display with other zooming factors.

Note: In Fast hard disk recording mode (Live streaming) you can also use the option Wait till next display in LIVE mode [ms] to avoid slowing down the acquisition only due to highly repeating image display.

Fast hard disk recording

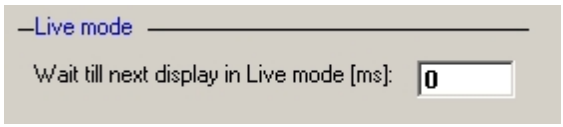
Fast hard disk recording

Fast hard disk recording starts the LIVE mode and writes all images to the specified frame.

The fast hard disk recording functions assumes that there is no acquisition in progress. If there is an acquisition in progress - even a LIVE mode acquisition the fast hard disk recording issues an error message and does not start.

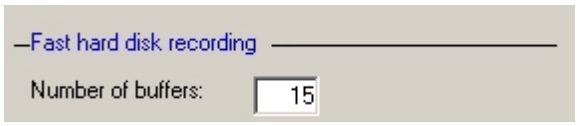
If the camera has a very high frame it may happen that image display speed slows down the overall acquisition speed. There is a way to completely switch off the image display. However this is not what a user normally wants. There is another way to acquire images with high speed without displaying all images in full speed.

There is an option in the acquisition options which allows specifying an interval time. Even if new live images are acquired they are not displayed unless the specified time has elapsed.



If for example we take a camera which outputs 150 frames / sec, we may want to save all images to hard disk (and this is normally possible because the image size is small in such case) but we do not need to display 150 frames / sec. If we specify 50 ms as a waiting time, the image display is limited to 20 frames / sec which is still sufficient for observing the image in real time but does not slow down hard disk recording.

If the grabber model which you use supports image buffering (Phoenix, X64, PCDig, PCCamLink, National Instruments boards, DCAM drivers), the buffers can be used and the buffer size can be defined by the user.



The number of buffers must be large enough to buffer timing interval where the hard disk is busy. Depending on the hard disk this is typically in the order of ½ or 1 second. The number of buffers has to be selected in a way that it can buffer images which arrive in this interval. If we acquire images from an ORCA in 2x2 binning mode we have a frame rate of approximately 16 frame / sec. If we assume a maximum busy time of the hard disk of ½ sec we have to provide at least 8 buffers. This number should not be larger than necessary because it consumes RAM memory but is should also be large enough to prevent lost frames.

During acquisition a display of the currently free buffers is visible and an information whether and how many frames have been lost.

If lost frames appear check the various counter measures described in the chapter Optimizations.

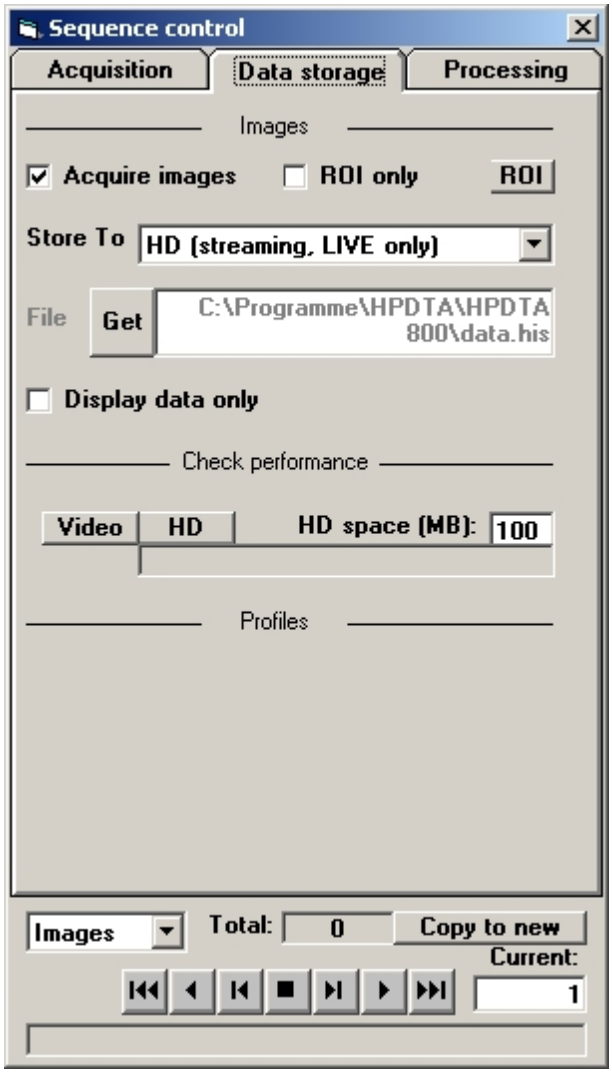
Data storage options

Sequence acquisition

Data storage options

To specify the data storage parameters select the data storage tab.

On this tab the user can define whether the software should store image and/or profiles and how and where to these data are stored.

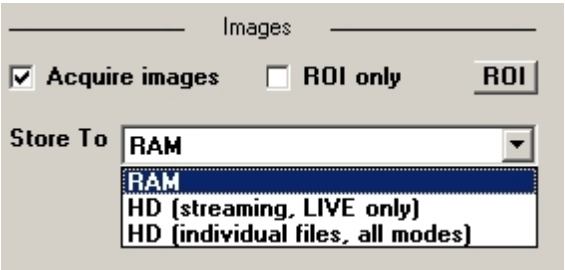


Storing images

Sequence acquisition > Data storage options

Storing images

In most cases the user wants to store images



To do so select Acquire images . As an additional feature the user can specify to store only part of the image. For this purpose he can specify a ROI from where image data is stored. To do so select a Rectangle ROI on the image click the pushbutton ROI and select the selection ROI only.

If you select **Store to RAM** the sequence will be recorded to the computer RAM. Use this in order to acquire a sequence with the highest speed. However you may also have to consider that the RAM is limited so the number of images you can record is limited. If you specify a

loop number larger than the amount of physical memory, the software only acquires a smaller number of images and stops then.

For storing to hard disk there are two possibilities:

- HD (streaming, LIVE only)
- HD (individual files, all modes)

HD (streaming, LIVE only) is also called fast hard disk recording or just streaming is the fastest way to save image data to file. It is however limited to LIVE mode and full speed acquisition.

In other cases like Analog Integration mode or fixed interval you have to use HD (individual files, all modes). In such cases the Store to selection does not offer the possibility of HD (streaming, LIVE only). Please see also the appendices ITEX Sequence, TIFF Sequence, ASCII Sequence and HIS Image sequence file.

Differences between storage modes

Sequence acquisition > Data storage options

Differences between storage modes

There are several differences between these three modes. The following table shows the most important differences.

Topic	Store to RAM	HD (streaming, LIVE only)	HD (individual files, all modes)
Space	Limited to free physical RAM space	Limited only to HD space	Limited only to HD space
Permanent Storage	Has to be saved to individual files after acquisition	One single file	Many files linked only by naming
Acquisition mode	All acquisition modes	LIVE mode and full speed acquisition only	All acquisition modes
Speed	Fast, can acquire in full speed from every camera	Fast, but limited to hard disk performance. A sophisticated buffer management tries to avoid lost frames	Slow
ROI	Can acquire ROI	Can acquire ROI. Allows to save only display data (data reduced to 8 bit)	Can acquire ROI
File type	*.img, *.tif,*.dat,*.his	*.his	*.img, *.tif,*.dat
Corrections	All corrections available	Images have to be saved to individual files first, then all corrections available	All corrections available
File management	The Windows Explorer may take long time for file management operations if the number of files is larger than 10000.	No problems with Windows Explorer. File size may be eventually too large to move (Several GB can be acquired within short time)	The Windows Explorer may take long time for file management operations if the number of files is larger than 10000.
Security against	In case of hangup data is lost.	In case of hangup data is lost.	Data acquired until hangup is available.

hangup			

Additional features and limitations of fast hard disc recording

Sequence acquisition > Data storage options

Additional features and limitations of fast hard disc recording

Please consider following limitations of the **Fast hard disc** recording mode: It applies to images acquired in Live mode only. It applies only to sequences acquired at full speed. If the grabber model which you use supports image buffering (Phoenix, X64, PCDig, PCCamLink, National Instruments boards, DCAM drivers), the buffers can be used and the buffer size can be defined by the user. A precise time stamp can be expected only if Phoenix, X64, PCCamlink or PCDig frame grabber boards are used. With other configurations (especially in all configurations used with DCAM) the time stamp may not be accurate.

You have the additional possibility to save data as 8 bit only if you additionally check **Display data only**. The images will be saved in a contrast setting as displayed on the screen.

Please make sure that the LUT setting is reasonable before you acquire an image with this option selected. If you are using a camera with more than 8 bit per pixel output, the **Display data only** function will reduce the amount of data to be saved. Even a computer with limited performance may be fast enough to save such sequences.

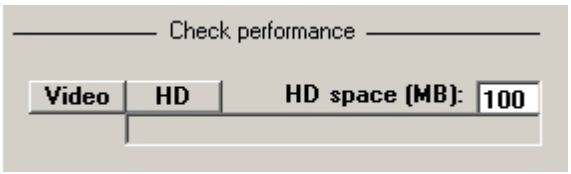
The data saved in fast hard disc recording mode is written to one single file. This avoids delays due to file management but may be difficult to handle once the file is very large.

Check performance of hard disk recording

Sequence acquisition > Data storage options > Additional features and limitations of fast hard disc recording

Check performance of hard disk recording

You can check the performance of your recording system for the fast hard disk recording mode.



If you click the **Check perform. Video** button, the time needed to display an image on your monitor will be measured and displayed.

If you click on **Check perform**. **HD** the performance (byte per second) of your hard disk will be checked with a file size as determined by the **HD space (MB)** parameter. Before you click on the **HD** button you have to insert a reasonable figure in the **HD space (MB)** text box. The measurement may take several minutes depending on your computer performance and file size selected.

Specifying file names

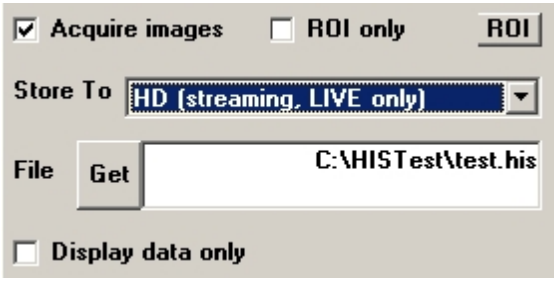
Sequence acquisition > Data storage options

Specifying file names

If a sequence should be saved to a file or a set of files additional controls for file specification will appear.

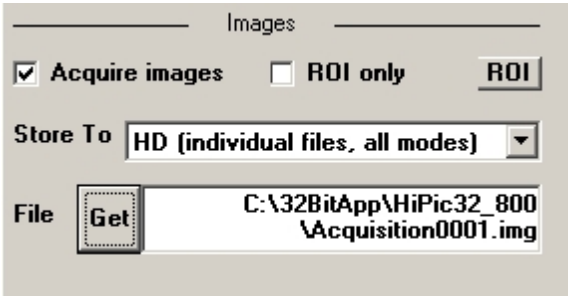
In the case of fast hard disk recording one has to specify a single file with the extension *.his. To browse the hard disk for a directory and file name click to the pushbutton Get.

Additionally the user can specify whether only 8 bit data (as displayed on screen) should be saved. To do so select the option Display data only.



In the case of storing images to individual files the images are stored to a set of images linked by the same base name added by a number indicating the individual sequence image.

In this case the user has to specify a single file with the extension *.img or *.tif or *.dat but with a number for the start of the sequence. To browse the hard disk for a directory and file name click to the pushbutton Get.



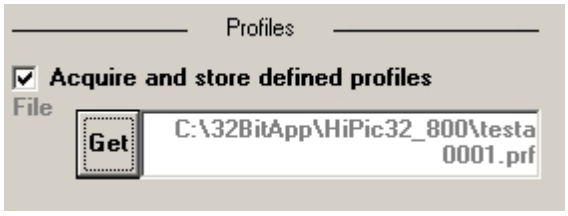
Note: Please make sure the number of digits is large enough to number all images. Example: If you want to acquire 5000 images you need to specify at least four digits in the file name.

Storing profiles

Sequence acquisition > Data storage options

Storing profiles

In other cases the user wants to store profiles (or images and profiles).



If you select **Acquire and store defined profiles**, all intensity profiles with defined and displayed ROIs will be stored. You have to select the file name in the file text box. Profile sequences are always stored to disk.

Image Sequence display (normal images)

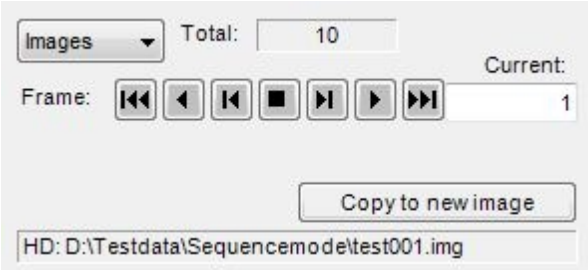
Sequence acquisition > Data storage options

Image Sequence display (normal images)

To control the display and replay of a sequence the controls on the lower part of the sequence dialogue are used. If you run the program in demo mode you still can display and replay existing sequences.

Unless a sequence is already opened, you have to open a sequence using the File Open dialogue or acquire a new sequence.

Select **Images** in the Sequence control Acquisition dialogue to display a sequence of images (only necessary if an image sequence and a profile sequence are currently loaded).

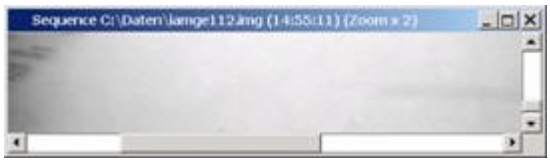


The controls in the center are used to specify the image within the sequence. The text box **Current** shows the index of the image currently shown. You can enter the desired image number, switch to the first (with ⏮) or last image (with ⏭) or switch to the next (with ⏯) or previous image (with ⏮). You can automatically replay the sequence backward or forward with the controls ▶ and ◀. The parameter **Interval** in the sequence options defines the time for which each image will be displayed.

If the parameter **Wrap** in the sequence options is selected, the sequence display will be continued until the user stops it by pressing the ■ (=Stop) button.

If you want to extract a single image from the sequence you can use the push-button **Copy to new image** to create a single image with the same data as the current image. This is displayed in a separate window.

The currently displayed image within the sequence contains some useful information in the window title bar: The word "Sequence", the file name (or the image number if the sequence is not yet saved), the time and the zooming factor. If the image is the first image within a sequence the time parameter shows the time when the image was acquired (11:08:09). If it is another image it shows the offset to the first image in milliseconds (e.g. 147 ms). Therefore an exact timing can be reconstructed. If **Full speed** was selected during acquisition the time when the image has been read out completely is registered, if **Fixed Timing** was selected the start time of the acquisition command is registered. This is normally more precise.



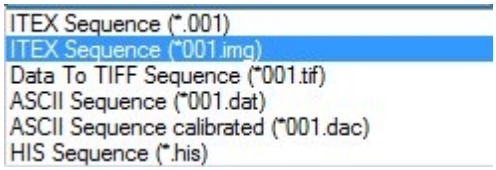
Title bar of a sequence image

Sequence image file naming conventions

Sequence acquisition > Data storage options

Sequence image file naming conventions

When you select the **Save as..** function within the **File** menu you will find several formats to save image sequences:



Save as.. *file type list*

1. ITEX sequence
All images of a sequence are saved to separate ITEX-files. These files are only linked together by the naming convention. There are two possible naming conventions:

*.001 format
Example1: Starting name: TEST.001
Sequence: TEST.001, TEST.002, TEST.003 ...
Example2: Starting name: TEST.031
Sequence: TEST.031, TEST.032, TEST.033 ...
Note: This format should not be used any more, since it may not be supported in future versions of this program. It is only provided due to compatibility reasons with previous versions.

*001.img format
Example: Starting name: TEST145.IMG
Sequence: TEST145.IMG, TEST146.IMG, TEST147.IMG etc.

The default extension is 001 and the user only has to select a file base name. In this case the files are named NAME.001, NAME.002 etc.

When saving a sequence one has to select the starting name. All other file names are derived starting from this file name:

Note: The numbering can have up to 7 digits

2. TIFF sequence format.
There are two ways to save image sequences in TIFF format:

2.1. **Data to TIFF** sequence
Images are saved in 8 or 16 bit TIFF format, depending on the depth of the image buffer. If the image buffer is 8 bit, TIFF will be 8 bit deep, otherwise it will be 16 bit deep.

"Data to TIFF" preserves the measurement data. The saved image data do not depend on the LUT settings, although the LUT settings are saved in the TIFF header and restored from it when re-loading such an image.

2.2. **Display to TIFF** sequence
Images are saved in 8 bit TIFF format. This is a color-palette format. If the LUT is grayscale when saving the TIFF file, the palette contains gray scales, otherwise it contains hued colors.

"Display to TIFF" does not preserve the measurement data. Its purpose is to store pictures which look like the image on the monitor screen. So, the contents of image data depend on the current LUT settings. Use "Disaplay to TIFF" if you want to save images for presentation purposes, but never try to store your measurement data this way!

3. **ASCII** sequence
Images are saved in ASCII format. Note that ASCII format does not preserve any calibration information.

The files created can be read with the **Open** function (however ASCII files can not be read by this program). Depending on the file format you choose, you can either display single images or a whole sequence.

If you execute image processing operations on a sequence all sequence images are treated in parallel. This is true for **Background subtraction** (the background image is taken and is subtracted from all images**), Shading correction**, **Curvature Correction, Arithmetic operations** and **Map values by LUT**.

4. **HIS** sequence
All images of a sequence are saved in one single file. This allows using full performance of your computer system. It is the fastest way to record images on hard disk. You have to use this format if you use the **Fast hard disk** recording mode.

Profile sequences

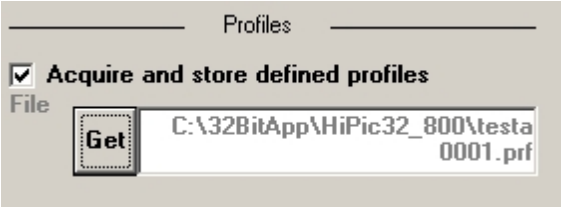
Profile sequences

This chapter shows how to handle profile sequences.

Profile sequence acquisition

Profile sequence acquisition

Select **Acquire and store defined profiles** in the Sequence Data storage dialogue to enable recording of profile sequences.



Also a base file name or the name of the first profile within the sequence has to be defined. During sequence acquisition the system adds four digits to the base name: The first digit specifies the profile memory number and the last three or four digits the number of the series. For example a profile name test6001.prf indicates the profile memory number 6 and the first exposure

Before you can start to record a sequence of profiles, you have to get a sample images and define the profiles.

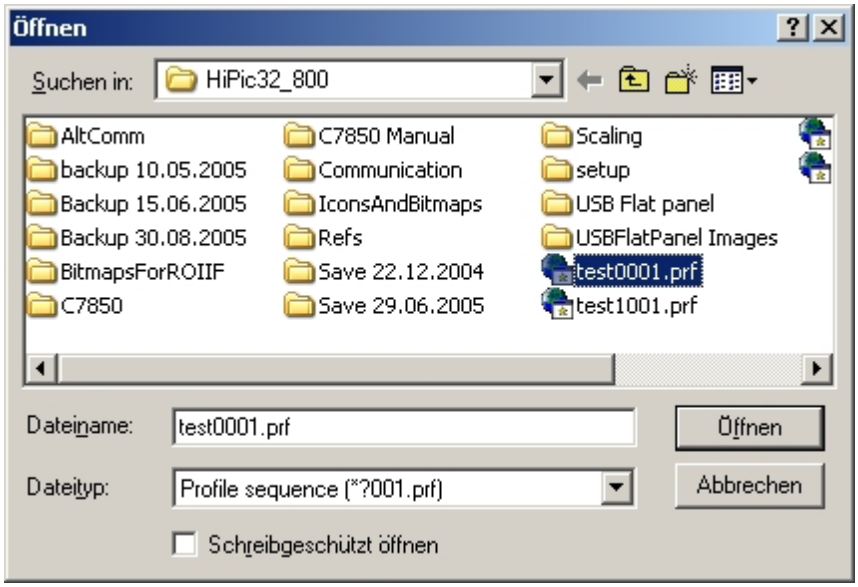
Profile sequences are recorded for all profiles for which ROIs are defined.

Then you have to define the timing parameters of a sequence as described in the chapter above. After pressing **Start Acquisition** a series of profile files will be stored.

Profile sequence display

Profile sequence display

Unless you have just recorded a sequence, you need to load one from disk before you can display it . Use the **Load** function of the profile dialogue in order to open a profile sequence. You have to select Profile sequence in the file type selection, otherwise only a single profile is loads. If there have been several profiles where a ROI was specified then several profiles are loaded at the same time. All these profiles together are called one sample (In the case of images as sample is always on image).



Select **Profiles** in the Sequence control Acquisition dialogue to display a sequence of profiles. The way how to use the profile sequence dialogue is analog to the image display.

Processing sequences

Sequence acquisition

Processing sequences

It is possible to do some post processing operations with image and profile sequences. Choose the **Processing** tab from the **Sequence control** to display the dialogue for sequence processing. It is possible to

- Average a number of images or profiles
- Do jitter correction

Sequence processing dialogue

Arithmetic

Arithmetic

When averaging or jitter correct images or profiles, different options for the data processing can be used.

Method	Normal Images	Photon counting Images	Normal Profiles	Photon counting Profiles
Conventional	Averaged and aligned to 15 bit boundary	Added Up	Averaged	Added Up
Average	Averaged	Added Up	Averaged	Added Up
Add	Added Up	Added Up	Added Up	Added Up

The data storage type of the result image will be a 16 bit normally. It will be 32 bit type if the original images are 32 bit images or if the option Add is used.

Align to 15 bit boundary means that the full dynamic range of signed 16 bit images is used to avoid rounding errors. Technically speaking it means a bit shift by to shift of (15-n) to the

MSB where n is the bit depth of the single image (12 for a 12 bit image).

Please use the option Processing Arithmetic to select the method.

The word Conventional means that previous versions always used this somehow complex but reasonable arithmetic method.

Averaging

Averaging

If you press **Average**, all data (images or profiles) of the current sequence will be averaged. This can be used for creating noise reduced data.

It is possible to exclude some data of the sequence from averaging. This is e.g. useful, if one or several data of the sequence show unwanted contents.

Display the data you want to exclude from averaging and click **exclude this sample** in order to eliminate this data from averaging.

Finally, hit the **Proceed** button.

In case of image data, the result will be displayed in a new image window. In case of profiles, the result will be displayed in the **Profile Display** window.

Jitter Correction

Jitter Correction

This chapter describes how to operate Jitter correction.

Purpose

Purpose

The purpose of this function is to increase the quality of single shot measurements if a single shot has not enough statistics and ordinary integration is not possible because of a large sweep to sweep jitter.

The jitter correction function allows summing up images or profiles containing signal which may be shifted on the time axis due to trigger jitter without losing temporal resolution. This is especially useful if the signal level for a single sweep is low and a single image would have too low statistics.

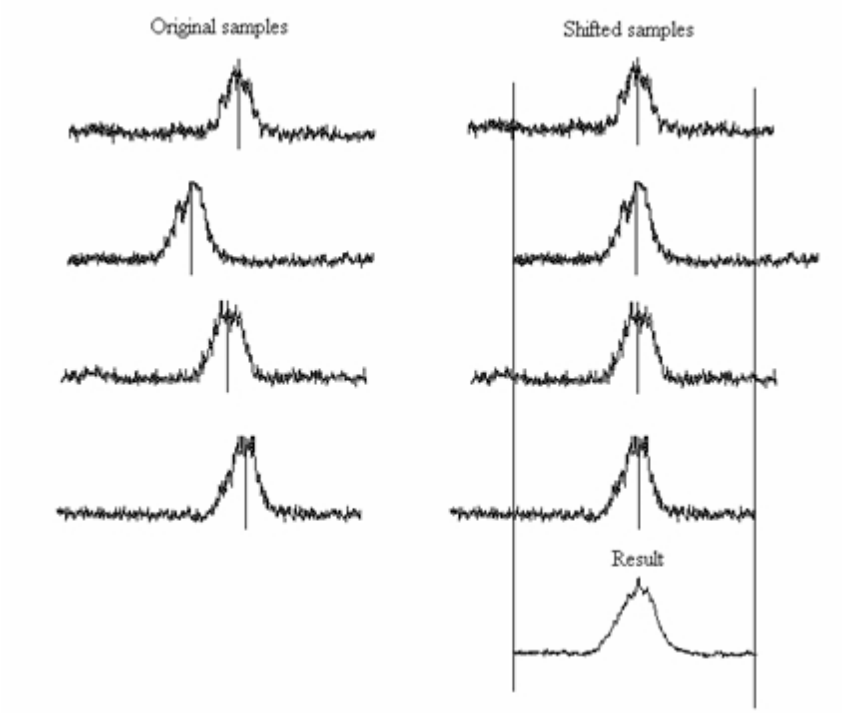
Under certain conditions this function is also applicable to data where a s lowly varying drift appears.

Principle

Principle

To perform jitter correction suitable samples are shifted along the time axis and overlaid with an image processing function. To determine to which position every sample has to be shifted

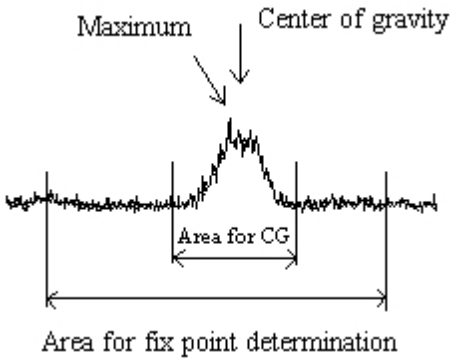
so called fix points are defined (see the following image). An additional feature of the jitter correction function is that samples with no good data can be excluded.



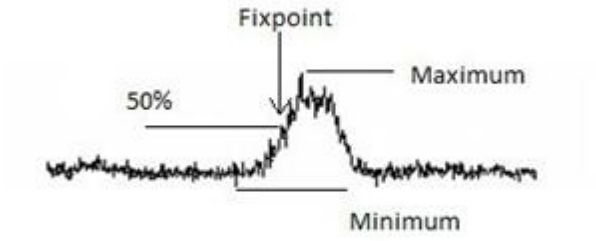
Both fix points and exclusion can be done automatically as well as manually and even in a mixed mode.

For the automatic fix point definition two methods are offered: A center of gravity as well as a rising edge method.

With the center of gravity method the center of gravity within a specified area around the maximum is calculated. This method is best suited for symmetric pulses.



With the rising edge method starting from the left the minimum and maximum value is calculated and where the curve passes the 50% between these points. This method is best suited for pulses with a short rise time.



.

For automatic exclude of samples an intensity threshold can be defined.

After the automatic fix point definition and exclusion we can manually modify both fix points and excludes.

Executing jitter correction step by step

Sequence acquisition > Processing sequences > Jitter Correction

Executing jitter correction step by step

To execute jitter correction the following steps have to be performed step by step:

Selecting data

Fix point definition

Preparation of data

Processing

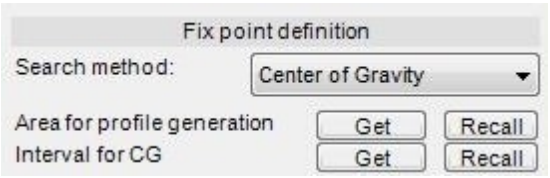
In the following it is assumed that we have an image sequence with the time axis in vertical direction. Other configurations like profile sequences are handled in a similar way.

Selecting data

We load the sequence into the sequence buffer and select Jitter correction as the processing type.

Fix point definition

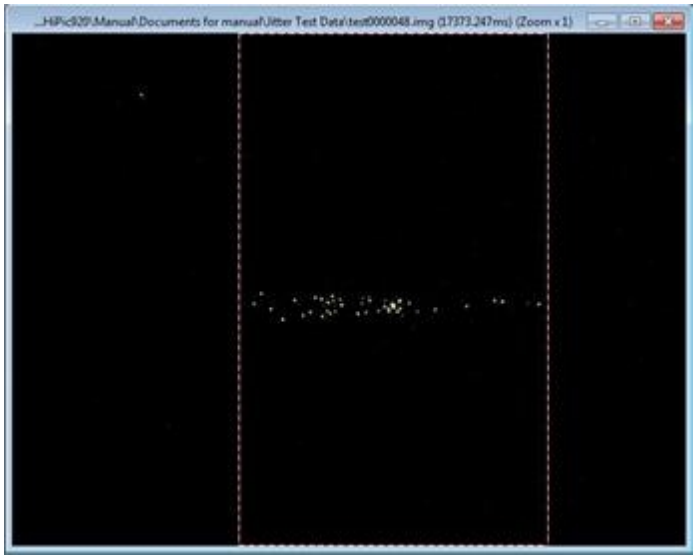
For this we use the controls in the following section:



First of all we have to select the search method among the possibilities Center of Gravity and Rising Edge .

Then we have define a full size vertical ROI (see ) to define, where profile data for the following process is extracted and confirm this area by clicking to the pushbutton labeled Get right to Area for profile generation .

Note: For profile sequences this step is not necessary.



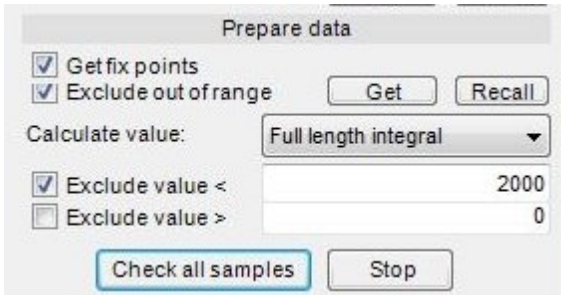
Within this area the center of gravity or rising edge is calculated.

If Center of Gravity was selected, we additionally have to select a full size horizontal ROI (see) to define the area used to calculate the Center of Gravity around the maximum and confirm this area by clicking to the pushbutton labeled Get right to Interval for CG .

Note: For profile sequences this step is done with the two analysis cursors.

Preparation of data

During this step we define fix points and which samples are excluded. For this we use the controls in the following section:



Checking the checkbox Get fix points will cause the program to automatically calculate the fix points once the Check all samples is pressed.

If we want to exclude all fix points which lay outside a certain range, we define this range and confirm it by clicking to the pushbutton labeled Get right to Exclude out of range .

Note: For profile sequences this step is done with the two analysis cursors.

If we want to exclude fix points based on a certain intensity we first have to calculate a value of every sample by selecting an entry in the combo-box Calculate value . The only choice currently is Full length integral . This will be done by clicking to Check all samples . Once this is done we will see the value calculated for every sample in the section Data info :

By looking through the samples we can easily decide the threshold for excluding samples. We

can exclude samples whose value is smaller then the threshold as well as samples whose value is larger then the threshold.

Finalize this selection by clicking to Check all samples .

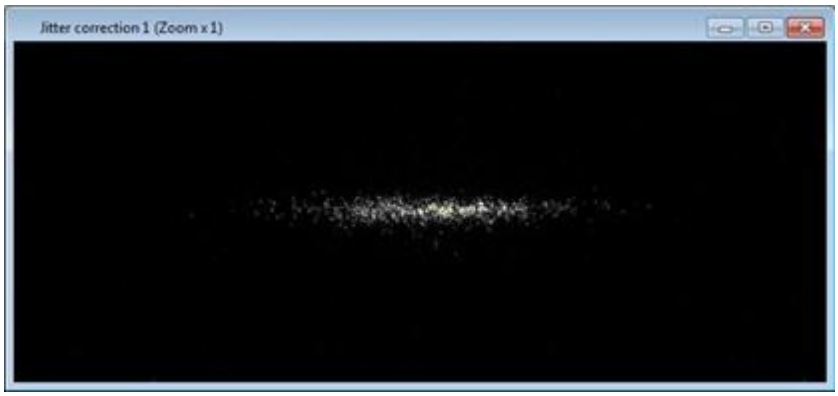
We can do this as often as we want until we are satisfied with the result.

Additionally we can also manually change the fix points and the exclude selection.

Processing

To really overlay all samples we just have to click to Process in a final step.

After a while the program outputs the overlaid image as the result:



The result is always smaller in the time axis direction, because only the overlapping area of all samples is used. To avoid a too small result we can exclude fix points out of a certain region.

Note: For profile sequences the result is displayed as a profile in the profile display window.

Problems and Limitations

Sequence acquisition > Processing sequences > Jitter Correction

Problems and Limitations

There are two cases which can disturb the process of jitter correction considerably:

1.) The data contain a large offset

2.) Each sample contains only very few photons

In the case 1.) the offset can cause a considerable deviation of the calculated fix point. Normally it is strongly recommended to perform background subtraction correctly. If you cannot use data without background you must carefully check the resulting fix points and modify them manually if you find deviations.

It is recommended that you use an **Interval for CG** as small as possible.

In the case 2.) the resulting pulses may be too narrow if there are too few photons. This is the limit of the method and if you do not have additional information about the real fix point you will not get correct results (just imagine what would happen if there were only one photon in every sample). In such cases you must try to find a stronger signal for fix point determination.

Jitter correction with DPC files and binary profiles

Sequence acquisition > Processing sequences

Jitter correction with DPC files and binary profiles

This chapter explains a specific way of performing jitter correction on DPC files when the fix

point is recorded on a so called binary profile.

Introduction

Introduction

In the case that the signal in one single shot is very small the jitter correction normally cannot be performed. This is especially true if photon counting is used to acquire data. If, however a marker pulse can be recorded at another location inside the image, the marker pulse can be used to get the fix points. With these fix points the recorded photon counting data can be jitter-corrected in the usual way. The HPD-TA provides a dedicated data processing method for this scenario.

Principle

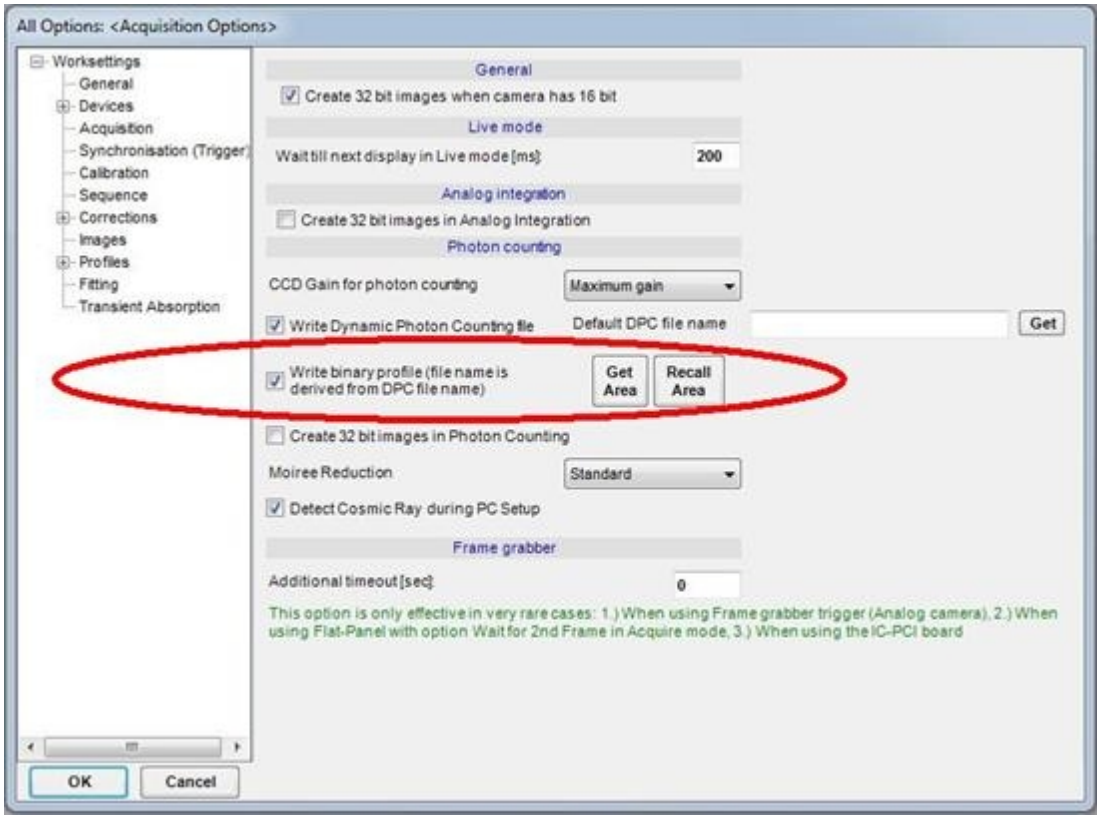
Principle

To make jitter correction with photon counting images possible, a so called marker pulse derived directly from the LASER is overlaid onto the streak image from the sample which should be used as fix point. During photon counting acquisition the photons are recorded in a DPC file which registers the photon coordinates together with the frame information. Simultaneously the profile data from a predefined ROI are stored for every frame. Due to performance reasons the profile data is stored in a binary format therefore we refer to it as binary profiles . During the jitter correction process the photon counting data is corrected using the fix points calculated on the basis of the profiles.

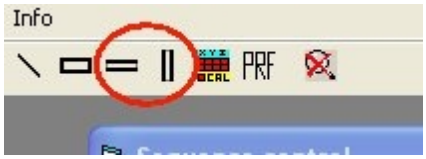
Data acquisition

Data acquisition

In the same way as we tell the system to store DPC files, we have to tell it to store binary profiles. The file name is derived from the name for the DPC file, just using the extension bpr instead of dpc.



Additionally we have to define a full size ROI in the direction of the streak sweep, where the system extracts the binary profile. This can be done by selecting an ROI **before** we enter the options dialog, and then click to Get Area behind the Write binary profile option. If a suitable image is currently selected we can also recall this area to check it (see the following two screenshots).



To start the data acquisition just click on Count at the Photon counting Tab of the CCD camera acquisition dialog.

The system asks for the name of the DPC file and starts image acquisition.

Files created

Files created

The system creates several files which contain the complete information about the acquired data. It is highly recommended to keep all this files together. All these files have the same name but different extensions. The following is a list of the files and its content:

Name.dpc (DPC file)

Name.bpi (binary profile information file)

Name.pbr (binary profile file)

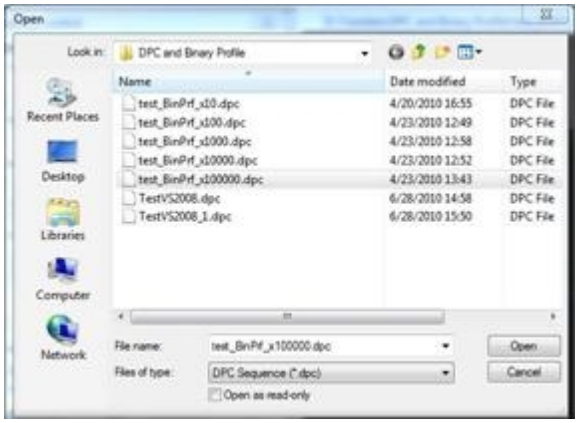
Name.scl (calibation file)

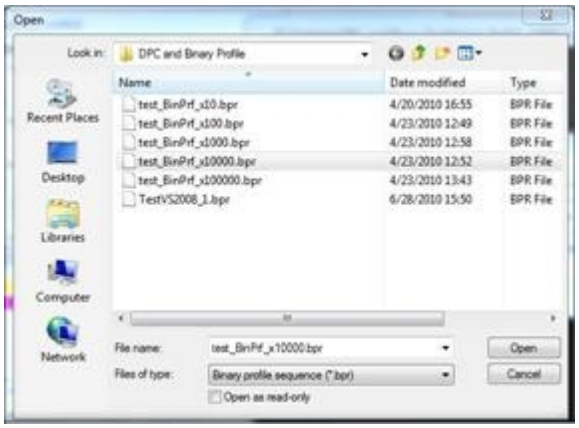
Name.prf (corrected profile, is calculated when jitter correction will be performed)

Loading of the data

Loading of the data

The complete set of data can be loaded with the file open command from the main menu or the load command from the profile tool (see screenshots).



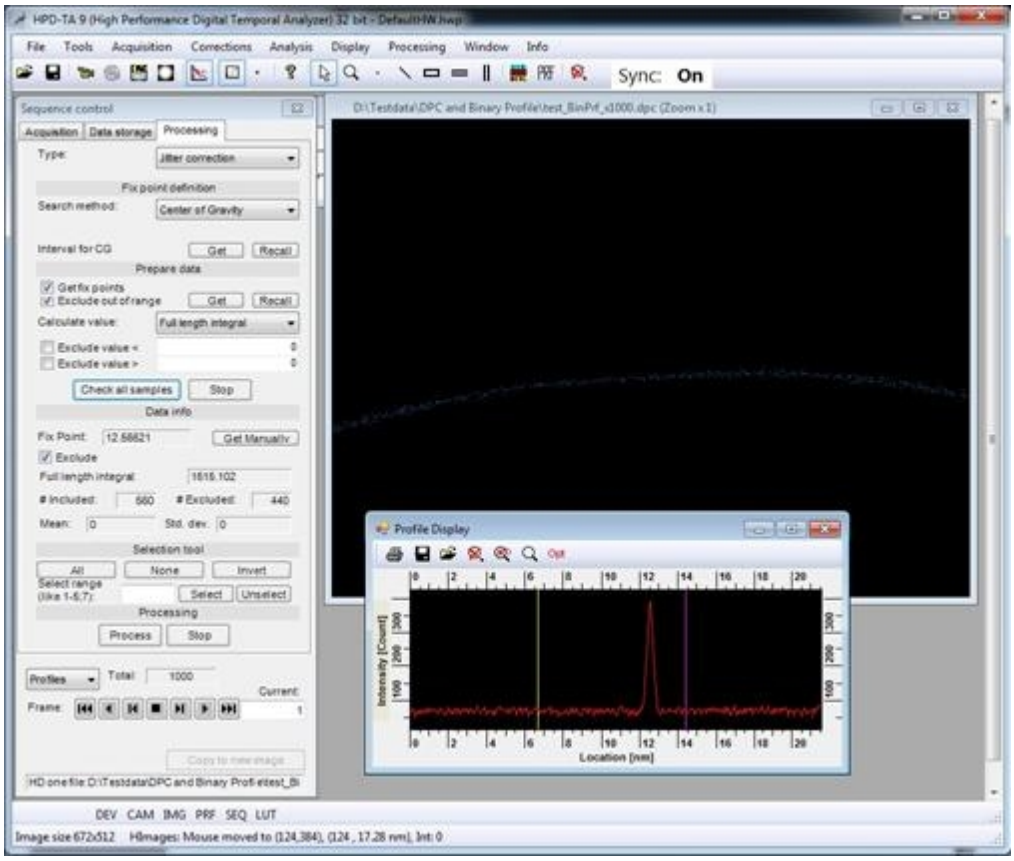


Important note: When an ordinary DPC file is loaded as a sequence the user normally gets the Dynamic photon counting load dialog which asks how to load this DPC file to the sequence:

If a DPC file which is recorded in combination with binary profiles is loaded, the system automatically loads it to a sequence which displays every frame individually as described in this chapter and the Dynamic photon counting load dialog is ***not*** *shown.*

If you want to load it using the Dynamic photon counting load dialog you have to move the dpc file without the other related files to another folder and then load it as DPC sequence .

After loading of the data the sequence dialog allows to view all samples both in the image display as well as in the profile tool (See the following screenshot).



Jitter correction

Jitter correction

Jitter correction is performed almost identical to the way an ordinary profile sequence is corrected. Please study the details in the chapter Executing jitter correction step by step before executing the jitter correction. Please be sure to specify the necessary ROIs (e.g. to specify the interval for CG detection) in the **Profile tool** and not in the image. When executing the jitter correction the result will be both in the profile tool, which contains then the overlaid profiles and in a separate image, which will contain the overlaid images.

Optimizations

Optimizations

The sequence mode is a rather complex and powerful mode. It can be influenced by many options and parameters. Sometimes the setting of a parameter influences the performance of the acquisition in a certain way. Generally speaking the more tasks the sequence should perform the slower it is. If you want to emphasize a specific performance parameter you should look at the following hints. We distinguish the topics according to the performance parameter speed, number of images and size and complexity on hard disk.

The following are suggestions what you can do if you do not reach the desired performance. Not all suggestions may yield the desired result and not all suggestion may lead to an improvement. It depends on the detailed circumstances which measure will lead to the desired performance.

Speed

Try the following measures if the program does not acquire images at the desired speed.

- Use acquire to RAM instead of Acquire to hard disk
- Use Fast hard disk recording instead of individual files if you need to write to hard disk.
- If you want to acquire profiles, acquire images only first, then extract profiles in a second step
- Even if you need individual files acquire to streaming file first, then convert to individual files.
- If using Acquisition to RAM:
  Use a value larger than zero in the sequence options Display Interval for Acquisition to RAM [ms] . This lowers CPU load used for display.
  or
  Completely switch off the image display during sequence (uncheck Always display image during acquisition)
- If using Live Streaming:
  Use a value larger than zero in the acquisition options Wait till next display in Live mode [ms] . This lowers CPU load used for display.
  or
  Completely switch off the image display during sequence (uncheck Always display image during acquisition)
- Use a fast hard disk when writing to files.
- Switch off the Option Average display if zoom < in the image options.
- Use 8 bit (display data) only (Warning: This reduces S/N of the data. Can eventually result in slower acquisition).
- Use an ROI for writing the data.
- Change the camera to a higher binning if possible.
- Switch off real time corrections (real time background subtraction, real time shading correction) and do these corrections afterwards.
- Do auto corrections after sequence acquisition.
- Uncheck Enable Stop when acquiring to RAM (Only rare cases, not recommended normally)
- Use Live mode or Acquire mode instead of Analog integration or Photon counting
- Use DPC mode and extract a sequence later instead of acquiring sequence of photon counting images
- Do not show quick profiles while fast hard disk recording

- Use bit packing when using fast hard disk recording (can eventually result in slower acquisition)
- Use a faster computer
- Increase the number of buffers for fast hard disk recording if lost buffers appear.

Number of images

Try the following measures if the program does not acquire the desired number of images.

- Use Fast hard disk recording or individual files instead of RAM.
- Use camera modes with less pixels like binning or sub array.
- Save ROI only.
- Close other applications when acquiring to RAM.
- Input more RAM in case of acquiring to RAM.
- Use an 64 bit OS and a 64 bit version of the software
- Use 8 bit (display data) only

Size on Hard disk or handling complexity

Try the following to reduce the amount of disk size which is used for the data or decrease handling complexity.

- Use camera modes with fewer pixels like binning or sub array.
- Use 8 bit (display data) only
- Save ROI only.
- Use Fast hard disk recording to save only one file
- Use bit packing when using fast hard disk recording

Photon Counting

Photon Counting

This chapter describes how to use and operate photon counting.

Introduction

Photon Counting

Introduction

Photon Counting *is a mode in which single photon events are added up in the frame memory. If the signal integration time is sufficiently long, a very high signal-to-noise ratio can be achieved. This mode also effectively suppresses certain crosstalk effects inherent to some image intensifiers and streak tubes. A dynamic photon counting mode allows temporal analysis of photon counting images.*

Required Hardware

Photon Counting

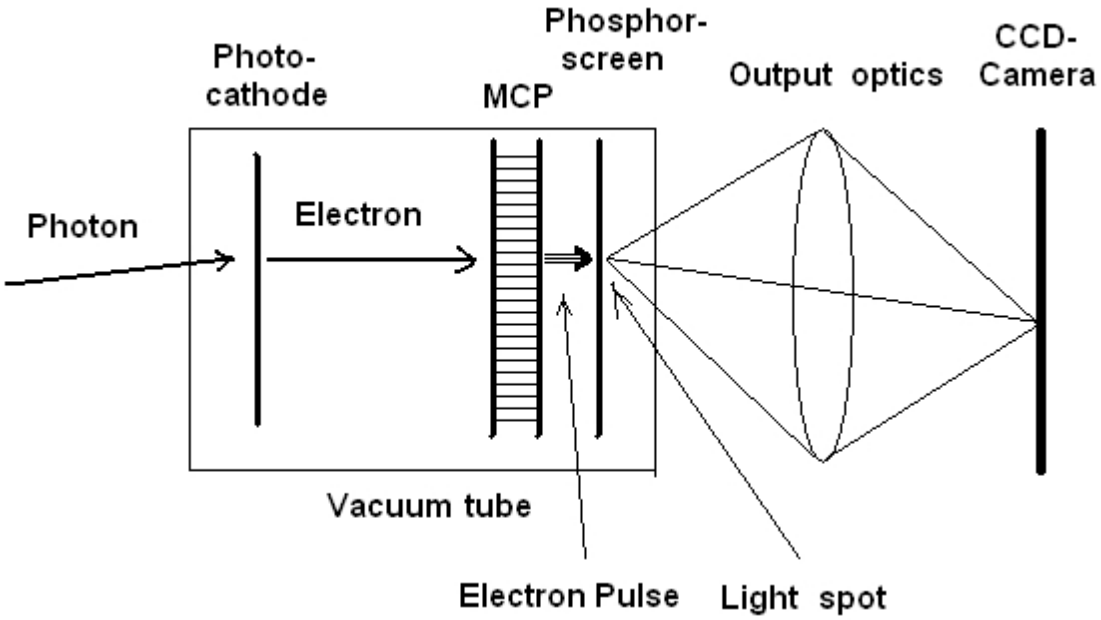
Required Hardware

Note: Photon counting mode is only possible if dedicate hardware requirements are fulfilled. A standard CCD camera is not able to perform photon counting.

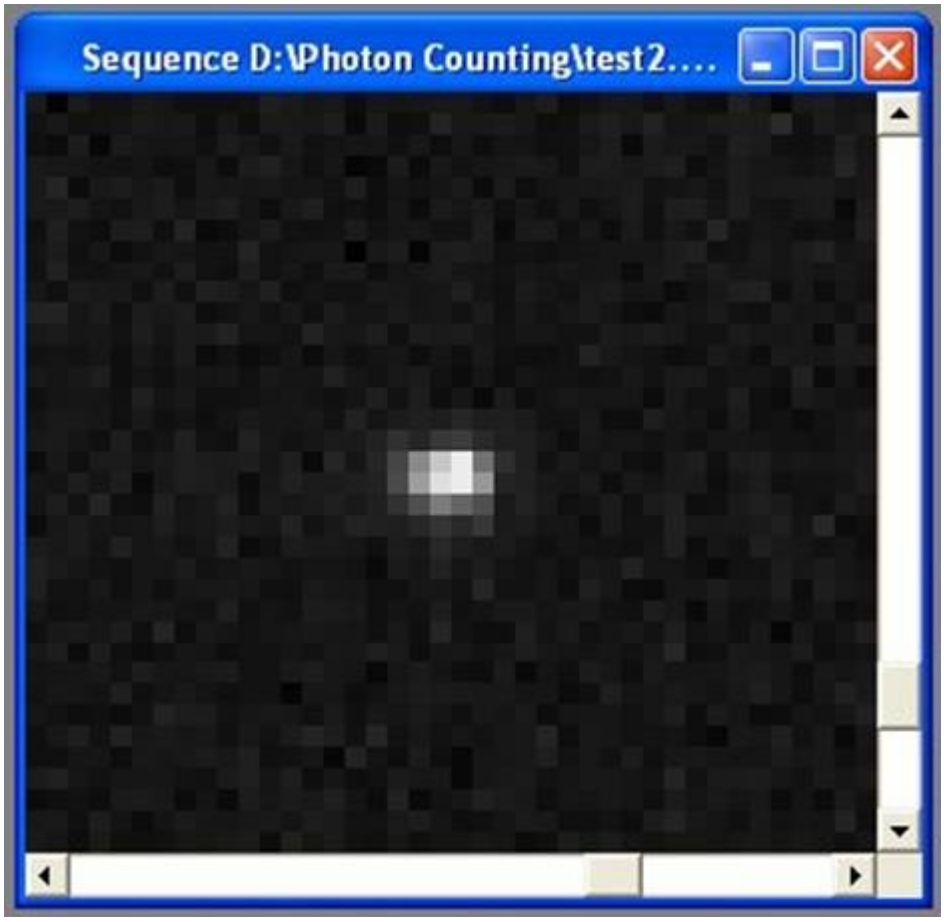
The following drawing shows the typical hardware required for photon counting.

It shows the vacuum tube including Photocathode MCP and phosphor screen as well as the output optics and CCD camera.

Starting from a photon an electron is created at the photocathode. This electron is multiplied inside the MCP and finally hits the phosphor screen. A small light spot is emitted at the phosphor screen and imaged to a CCD camera by the output optics.



The CCD camera finally registers a small light spot for every photon (see the following screenshot).



Conditions for Photon Counting Mode

Photon Counting

Conditions for Photon Counting Mode

This chapter explain which conditions have to be fulfilled to use photon counting properly.

Sensitivity to single photons

Photon Counting > Conditions for Photon Counting Mode

Sensitivity to single photons

Photon Counting requires that the system sensitivity is high enough to see single photon events. This is not the case if a CCD camera is used without any other light amplification device. Such a light amplification device could be an image intensifier whose gain is sufficiently high.

Every Hamamatsu streak tube (with a few special exceptions) is equipped with an internal micro channel plate (MCP) which yields a sufficient amplification to perform photon counting.

Low light level

Photon Counting > Conditions for Photon Counting Mode

Low light level

Photon counting can only be performed properly if the light intensity is low enough.

In case that the photon spot areas of two photons overlap at the same image on the CCD

they will be recognized as only one photon event. To avoid such a counting error the probability of a "two-photon event" should be low. It is important that this light level is not exceeded at any given or important location not just at the whole image in total. Please see also the above threshold value for details.

Basic principle of photon counting

Photon Counting

Basic principle of photon counting

This chapter explains the principle of photon counting.

Threshold

Photon Counting > Basic principle of photon counting

Threshold

The first principle of photon counting is that only the portions of the image are regarded where the intensity exceeds a certain **threshold**. Only these portions contribute to the result. The setting of this threshold is depending on features of the camera and of the photon spots which are recorded by the camera. This feature results in high processing speed which allows us to use photon counting in real time.

Reduce the spot information to a single count

Photon Counting > Basic principle of photon counting

Reduce the spot information to a single count

Another important feature of the used algorithm is that then whole information of a single photon spot is reduced to a single count.

Coordinate determination

Photon Counting > Basic principle of photon counting

Coordinate determination

The third principle is that for every photon spot we determine as precise as possible the coordinates of the photon. This allows us to perform a two dimensional photon counting.

Eliminating effects from long phosphor decay

Photon Counting > Basic principle of photon counting

Eliminating effects from long phosphor decay

If the phosphor screen has a long decay time it may happen that the photon spot appears also in subsequent frames. From version 9.3 a dedicated algorithm is used to ignore photon spots where already a photon is detected in the previous frame(s).

Photon counting algorithm and implementation

Photon Counting

Photon counting algorithm and implementation

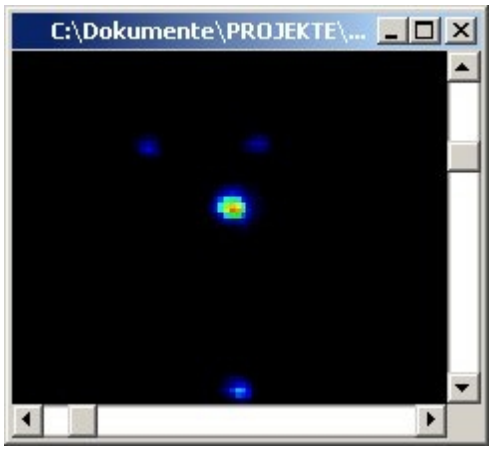
This chapter explains the photon counting algorithm and it's implementation.

Background subtraction and threshold calculation

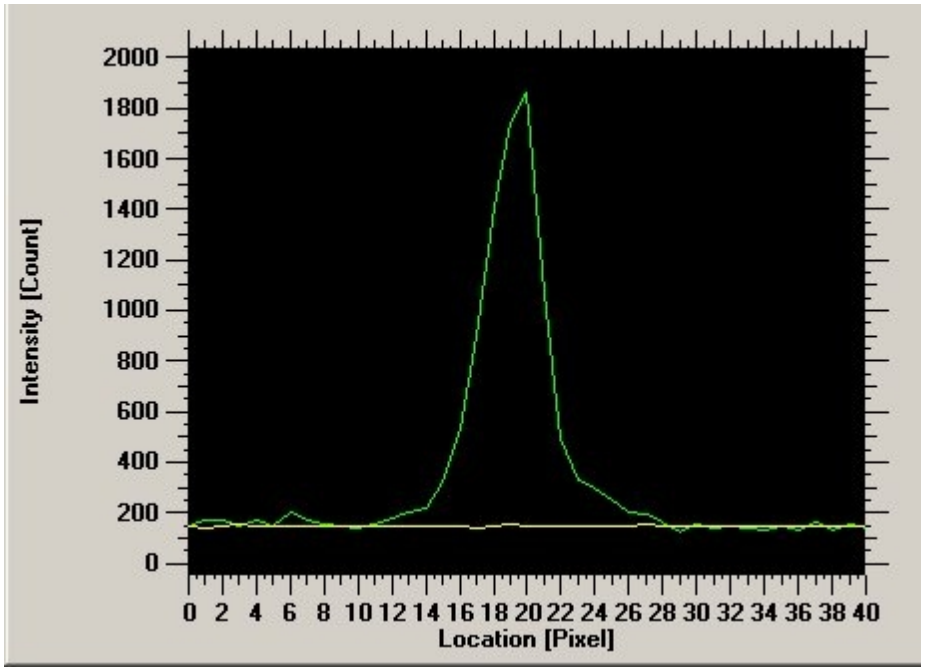
Background subtraction and threshold calculation

In a first step a background subtraction is performed and every pixel below a certain threshold is set to zero. The background subtraction reduces the effect coming from uneven CCD camera background (fixed pattern) or hot pixels.

The raw data of photon counting processing looks like:

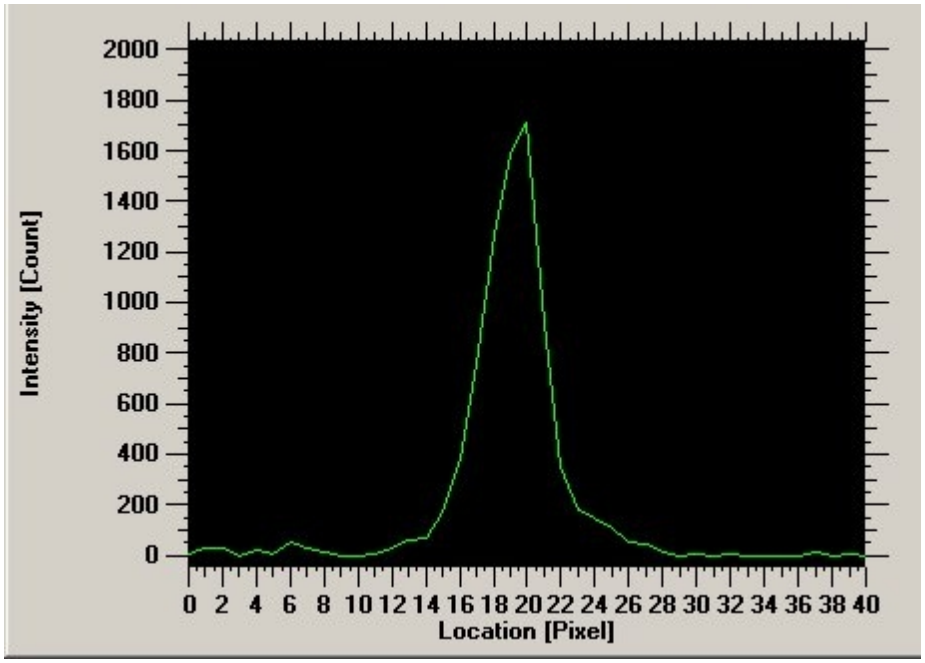


All processing steps are done with two dimensional data but for the ease of illustration we just use a one dimensional view of the data:

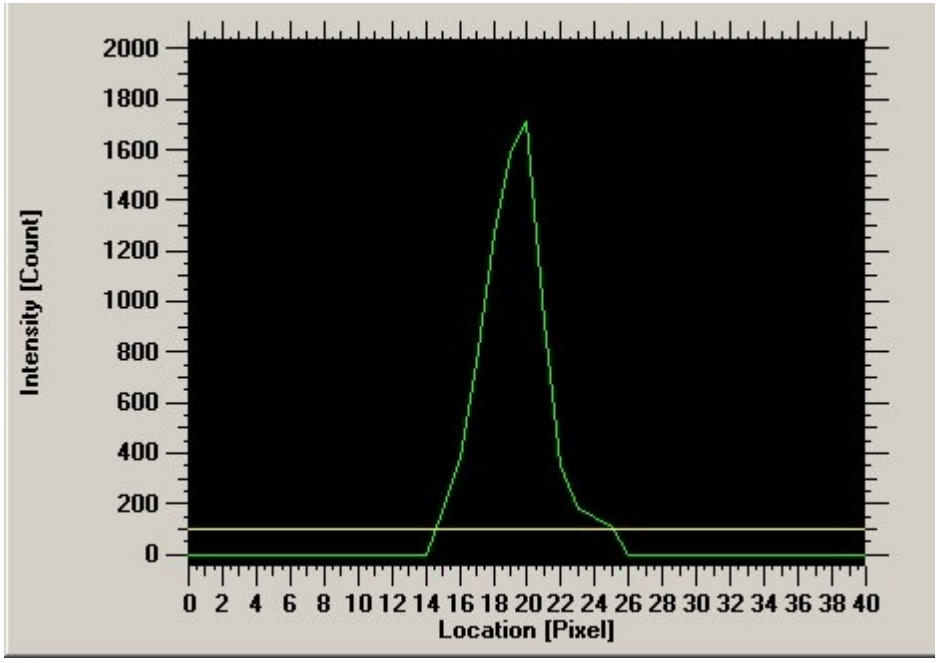


The green one is the raw photon data whereas the yellow one is the background data.

After background subtraction we get:



If we apply a threshold of 100 we get the following:



Coordinate calculation

Photon Counting > Photon counting algorithm and implementation

Coordinate calculation

Further processing steps uses only data which is non-zero, which increases processing speed drastically. For every photon we find its coordinates x and y. In our one dimensional example the location of the photon would be pixel 20.

Advanced processing

Photon Counting > Photon counting algorithm and implementation

Advanced processing

Advanced processing steps reduces moiré pattern which may appear in systems with discrete pattern of different size (in our case MCP and CCD) cells and handles bordering effect.

Data Storage

Photon Counting > Photon counting algorithm and implementation

Data Storage

The data is stored in an image which means that the frame buffer is increased for every photon at the photon location or it is written to a so called DPC file which allows performing dynamic photon counting analysis.

Counting errors and maximum count rate

Photon Counting

Counting errors and maximum count rate

This chapter explains about errors which can occur and the maximum count rate which can be reached.

Correct threshold

Photon Counting > Counting errors and maximum count rate

Correct threshold

An important factor for precise photon counting is the correct selection of the threshold. If the threshold is too low the system will count events which come from noise of the CCD system and which are no real photons. Be sure that the photon counting acquisition really counts no photons if there is no light.

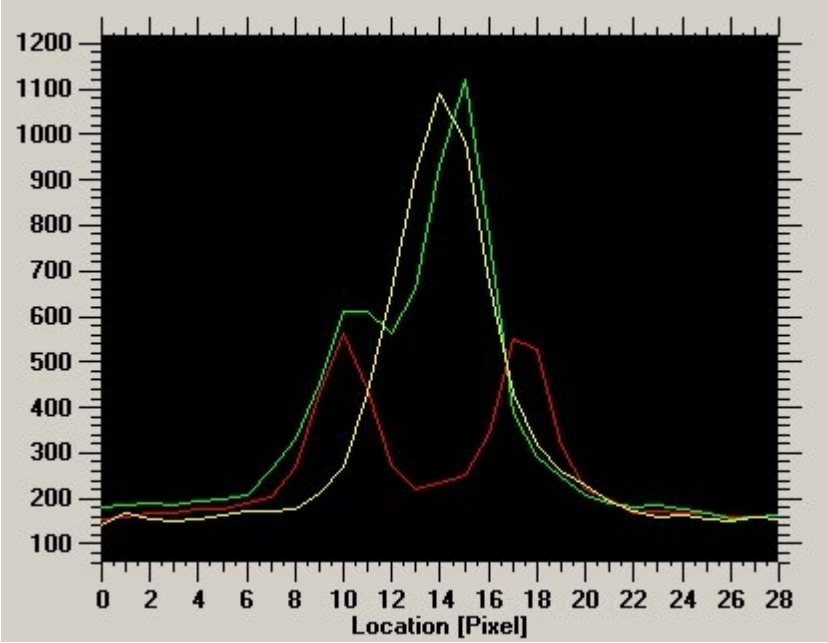
As the number of electrons arriving at the output has a certain distribution (we call this pulse height distribution) the brightness of the photons spots vary strongly. On other words: There are photons which produce a higher signal then others. If the threshold is too high, not all of the photons are counted.

Overlapping photon spots

Photon Counting > Counting errors and maximum count rate

Overlapping photon spots

The photon counting algorithm can count photons as individual photons only if they are separated from each other. The following screenshot will illustrate this. The red and green lines represent intensity distributions originating from two photons whereas the yellow line can be judged as a single photon only (even though there may have been two photons)



The probability of double photons which are counted as a single one because they overlap is a measure of the counting error.

A good indication of this probability is the percentage of the image which is "covered" by photons, in other words the percentage of the image which exceeds the threshold. The smaller this percentage is the smaller is the probability that a "new" photon hits an already recorded one. To keep this value small the "single photoelectron" probability should be made small by reducing the intensity of the light signal or minimizing the single photoelectron spot size. Increasing the frame rate reduces the number of photons detected on a single CCD frame thus decreasing the counting error.

Eliminating effects from long phosphor decay

Photon Counting > Counting errors and maximum count rate

Eliminating effects from long phosphor decay

If the phosphor screen has a long decay time it may happen that the photon spot appears also in subsequent frames. From version 9.3 a dedicated algorithm is used to ignore photon spots where already a photon is detected in the previous frame(s).

Maximum count rate

Photon Counting > Counting errors and maximum count rate

Maximum count rate

The maximum count rate we can achieve with a give system depends on the size of the photon spots, the CCD camera frame rate and of course on the required precision.

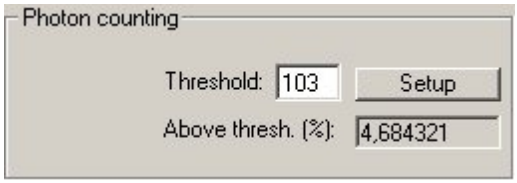
Above threshold value

Photon Counting > Counting errors and maximum count rate

Above threshold value

To find out whether the light intensity in a given area does not exceed a reasonable value the program outputs the so called above threshold value in the current ROI. To use this it is important that a **rectangular ROI is specified**! If no ROI or a wrong type of ROI is specified the program outputs the message No RECT ROI blinking in red color.

This program displays the current percentage of pixels above the threshold in a specified ROI. This value should not exceed a few percent (around 5%).



Operating Photon Counting

Photon Counting

Operating Photon Counting

This chapter describes how to operate photon counting.

Photon Counting Setup

Photon Counting > Operating Photon Counting

Photon Counting Setup

Before you start photon counting image acquisition **background data has to be acquired** and a suitable **threshold has to be set**. A sophisticated automatic setup routine has been implemented to acquire background data and automatically searches for the most suitable threshold.

Open the camera acquisition dialogue and select the photon counting tab and press **Setup** to start this routine. The program automatically acquires background data and performs histogram analysis. Then it starts photon counting acquisition in test mode to get an optimal threshold for the given system . Finally it proposes certain values necessary for the photon counting, as described in the chapter. Depending on the detector settings and type of detector, the procedure may take several minutes.

Note 1 During this setup the amplification device (MCP) should not be active otherwise wrong thresholds are calculated.

Note 2 If you did not perform Photon Counting Setup before you start photon counting acquisition, the system will prompt you to do so first. If you prefer to enter the threshold manually, you can ignore this message. This prompt is re-activated after you changed some parameters (like CCD exposure time) that can affect the proper threshold determination.

Note 3 In some rare cases the threshold has to be modified after photon counting setup to yield good results. In any case of doubt please contact your local Hamamatsu representative.

In case of a dual tapped camera like the C9300-201 two thresholds can be specified separately. The photon counting setup determines these two thresholds automatically.

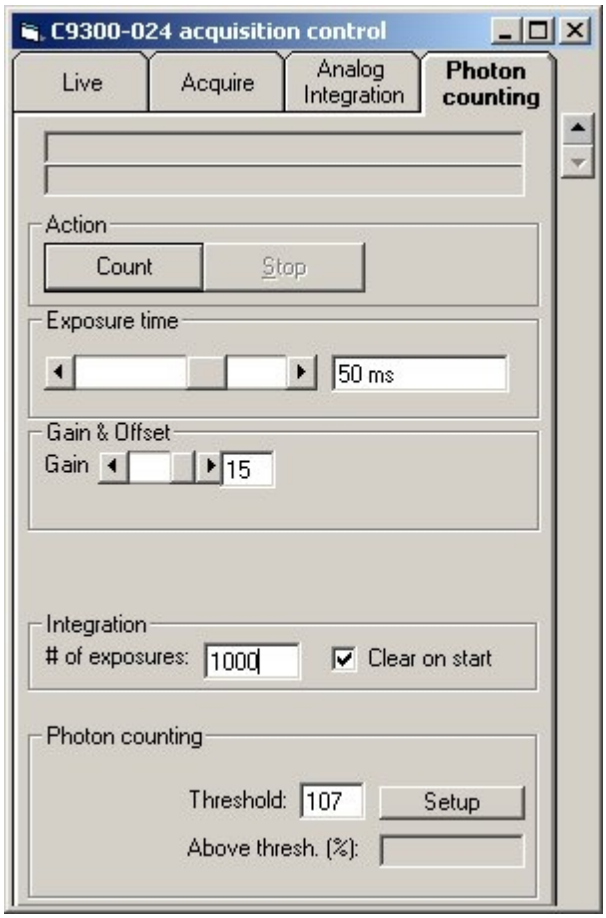
Photon counting acquisition

Photon Counting > Operating Photon Counting

Photon counting acquisition

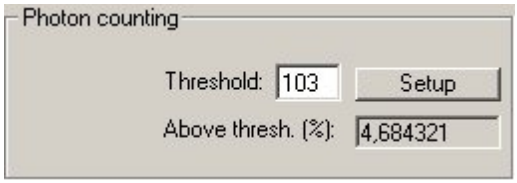
After you have executed Photon counting setup you can start to acquire photon counting data. Set your amplification device (MCP) to maximum gain, select the number of integrations

and start photon counting.

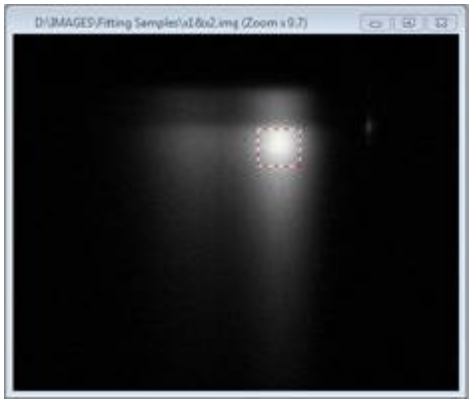


The exposure time can be set freely but it is recommended to set it close or equal to the camera frame time. If the exposure time is set smaller then the frame time signal is wasted (this may be desired if the signal is strong), if the exposure time is set larger then the frame time the maximum possible count rate is decreased.

The photon counting process is continuously monitored and two types of messages are output.



The first is information about the number of pixels which exceed the threshold. As explained earlier this value should not exceed 5%. Please make sure that an appropriate **rectangular ROI is specified**. If no ROI or a wrong type of ROI is specified the program outputs the message No RECT ROI blinking in red color! Specify this ROI in the area where the maximum intensity appears as can be seen in the following screenshot:



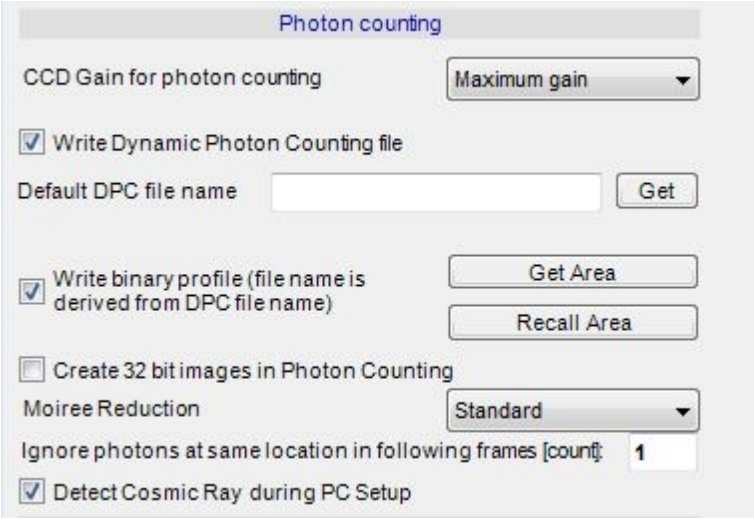
The system also monitors whether the CCD camera becomes saturated while looking at photon spots (Saturation always means loss of information). In such cases a warning message appears at the top part of the acquisition dialog and it is recommended to reduce the CCD camera gain (see also the option CCD Gain for photon counting). This message is only output in case of a problem.

Options related to photon counting

Photon Counting > Operating Photon Counting

Options related to photon counting

There are the following options related to photon counting in the acquisition options dialog:



The Selection box for **CCD Gain for photon counting** allows specifying the default CCD camera gain setting in photon counting mode. You can select between Maximum gain and Minimum gain . It is recommended to use Maximum gain unless the photon spots gets saturated.

If **Write dynamic photon counting file** is selected, the recording of photon counting images in the special DPC file format is enabled.

This file mentioned under **Default DPC file name** is suggested, when the option Write Dynamic Photon Counting file is active and Photon counting is started. In RemoteEx this option can be used to select the Dynamic Photon Counting file.

The option **Write binary profile (file name is derived from DPC file name)** is only valid in combination with writing DPC files (see above). When this option is active the system writes a binary profile (with extension bpr) from a predefined ROI with every new frame. Further to the dpc and bpr file the system writes some other files. If all these files are available the system can than perform a frame to frame jitter correction on the DPC data using the binary profiles to get the fix points. Please see the chapter Jitter correction with DPC files and binary profiles .

The **Get area** pushbutton allows to specify the ROI which is used by the Write binary profile function. A full length ROI has to be specified in the direction of the streak sweep **before** entering the options dialog.

The **Recall area** pushbutton allows to recall the ROI which is used by the Write binary profile function. An appropriate image has to exist **before** entering the options dialog which will then contain the ROI.

If **32 bit images in Photon Counting** is set result images in Analog Integration mode will always be 32 bit.

The selection of **Moiré Reduction** specifies how strong Moiré reduction should take place. It is recommended to keep this parameters at its default value Standard

The option **Ignore photons at same location in following frames [count]** specifies how many frame a photon spot is ignored if it has already been detected. This option can be used if a phosphor screen with long decay is used.

The option **Detect cosmic ray during PC setup** excludes frames which are much higher than average when performing PC setup. This option should normally be on. In rare cases the average of the CCD signal varies so strongly that normal PC setup fails. In such cases this option should be switched off. From version 9.3 this cosmic Ray detection feature has been improved to account for the specific noise characteristics of the individual CCD or CMOS cameras.

Dynamic Photon Counting (time resolved 2-D photon counting)

Photon Counting

Dynamic Photon Counting (time resolved 2-D photon counting)

The standard photon counting mode just accumulates the photons detected during the acquisition period. If you want to record also the time when a photon has been detected, you can use the Dynamic Photon Counting acquisition mode. If this mode is enabled, a DPC-type file will be generated where the x-y co-ordinate of each photon is registered as well as the time when it has been detected. In a later analysis step this file can be used for temporal analysis of photon counting images.

Please see also the Appendix DPC File Format for details.

Acquisition

Photon Counting > Dynamic Photon Counting (time resolved 2-D photon counting)

Acquisition

To activate the dynamic photon counting mode you have to select the item **Write dynamic photon counting file** in the menu Setup - Options- Display.

Then start photon counting image acquisition as described above.

Before the acquisition will start, a file name selection dialogue will be shown. There you have to define the file name of the file where the image data will be stored. For these files a special file extension is used: *.dpc. In this file the x-y co-ordinates of each photon and the time (CCD frame number) when it was detected are stored. The time resolution is limited by the frame rate of the camera you use for image acquisition.

In parallel to the data recording in the DPC file, an accumulated photon counting image is generated as described above.

Analysis

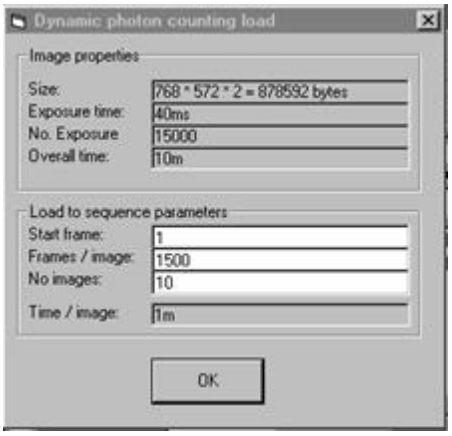
Analysis

There are two ways to use dynamic photon counting image files of the DPC format:

If you want to see the accumulated photon counting image without using the time information you can load the file by selecting the dpc file format in the File Open dialogue.

If you want to analyze the temporal information of a DPC file you have to open the file by selecting the dpc sequence format in the File Open dialogue. Then an image sequence will be generated from the file.

After you opened the file a dialogue is displayed where you can set several parameters of the image sequence which will be generated:



Dynamic photon counting load dialogue

In the upper part of this dialogue several basic parameters of the DPC file are displayed, like file size, exposure time of one frame, number of exposures and total acquisition time.

In the lower part you can set parameters of the sequence which will be generated:

Start frame sets the frame of the photon counting image at which the sequence will start. **Frames /image** define the number of frames which will be accumulated for one image of the sequence and **No images** defines the number of images of the sequence.

Example (shown in above dialogue): If data were recorded with 15000 camera frames and you intend to split the data into 10 images, each image will be calculated from 1500 frames.

Set the **No. images** parameter to define the number of sequence images you want to generate. Wrong inputs are automatically corrected. The header of the sequence images will show the time of the first image of the time frame.

Click **OK** to generate the sequence after you defined the sequence parameters. The generated sequence is a normal image sequence and can be treated in the standard fashion.

For information about handling and analysis of image sequences please refer to the chapter.

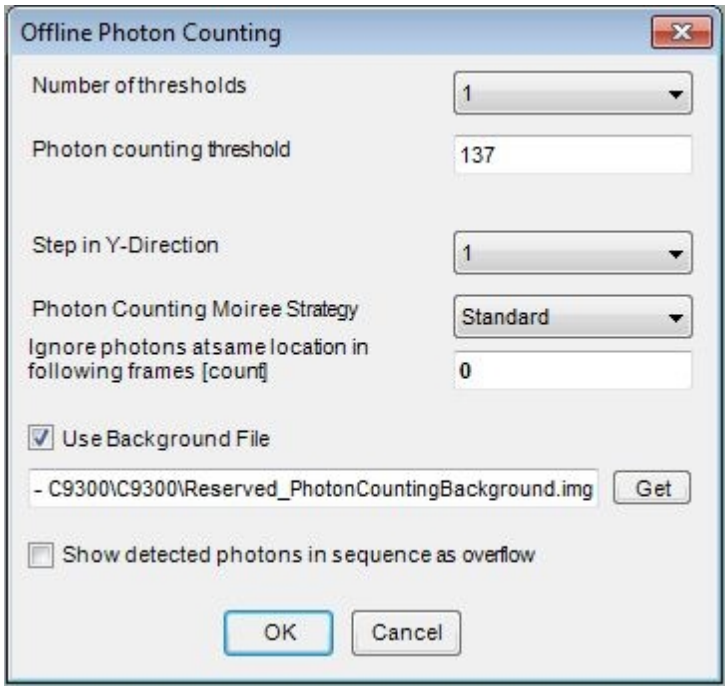
You can find a description of the DPC file format in Appendix F. You can use this if you want to use your own program for analysis of DPC files.

Offline photon counting

Offline photon counting

Offline photon counting can be performed on the basis of sequence data. To perform Offline photon counting right click with the mouse to a sequence and select:

Then please select the photon counting parameters:



Select the appropriate parameters and click to OK. A message box will appear telling you the progress of offline photon counting analysis and the value of the **Above Threshold** parameter.

From version 9.3 an option **Show detected photons in sequence mode as overflow** can be selected. This is useful to check the photon counting process and to verify its proper operation. Please note that this function modifies the original sequence data as it sets the pixel value of the detected photon to overflow.

Reserved Filenames

Photon Counting

Reserved Filenames

Please note that the photon counting setup saves the background data to a special file inside the Common Appdata directory (Under Windows 7 this is C:\ProgramData\Hamamatsu \HPDTA). Do not delete or modify the following reserved file:

`Reserved_PhotonCountingBackground.img`

Otherwise photon counting may no longer work as expected.

Image processing

Image processing

This topic describes how to apply image processing function.

Arithmetic

Image processing

Arithmetic

Arithmetic operations on an image or among two images can be made by using the Arithmetic commands.

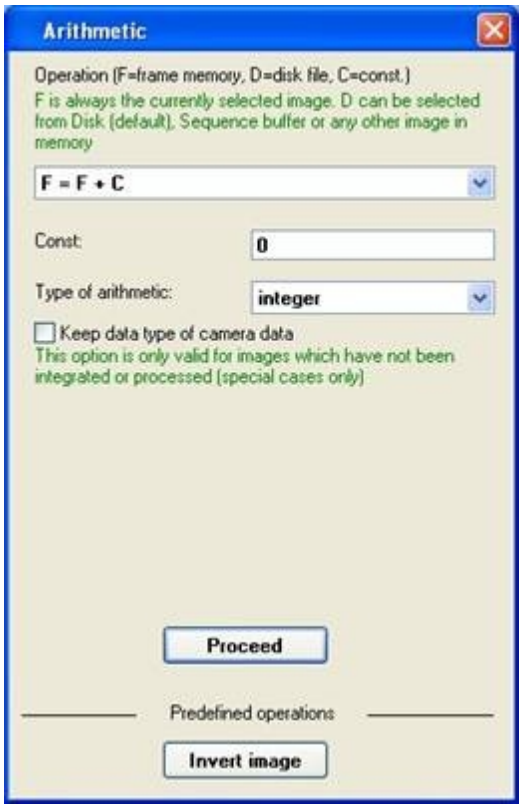
General

Image processing > Arithmetic

General

Choose **Arithmetic** from the **Processing** menu to display the Arithmetic dialogue.

The Arithmetic dialog will appear.



Arithmetic dialogue

The arithmetic functions can be used for tasks like subtracting or multiplying two images. These functions will always work on the current image and will change that image.

Caution: Save your original image first if you need to keep it.

Both, unary and binary operations are possible. In case of binary operations the first operand is always the current image and the second operand is always an image in a file on a disk.

Note: You can select a partial area of the image and the function will be performed only inside that area.

Important: Please make sure that no rectangular ROI is selected if you want to perform the operation on the whole image!

In case of binary operations the system always automatically calculates the overlapping area between the two images and will perform the function only on that area.

Selecting Constant and Arithmetic type

Image processing > Arithmetic

Selecting Constant and Arithmetic type

In addition, for all functions (also the unary ones) a constant may be defined as a calculation parameter. This constant has to be input into the edit box named **Const.**

You may also specify which type of arithmetic is used for the calculations, (long) integer or floating-point arithmetic. If the given constant is an integer value by default the arithmetic type is integer but you can force the program to use floating-point arithmetic, if you like. Choose the desired radio button in the frame **Type of arithmetic used.**

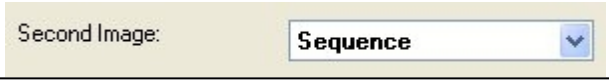
After you pushed the **Proceed** button the program calculation will start.

Note: The time required for a calculation will depend on the speed of your computer.

Second image

Second image

In the case a second image is required for the operation the user has to select the type of second image. He can select from the following selection:

Disk	The second image will be loaded from disk. A file name has to be specified in the case 
Sequence	The currently selected image from the sequence buffer will be used. 
Image in memory	An image which is already loaded to memory will be used. 

Available operations

Available operations

The following unary operations are available:

F=F+C	Adds a constant (integer only)
F=-F+C	Inverts the frame-buffer contents (integer only)
F=F*C	Multiplies the frame-buffer by a constant (integer or float)
F=F/C	Divides the frame-buffer by a constant (integer or float)
F=ln(F)*C	Calculates the natural logarithm (float only)

The following binary operations are available:

F=F+D+C	Adds a constant and a disk file to the frame-buffer (integer only)
F=F-D+C	Adds a constant and subtracts a disk file from the frame-buffer (integer only)
F=F*D/C	Multiplies the image in frame-buffer with a disk file (integer or float)
F=F/D*C	Divides the image in frame-buffer by a disk file (integer or float)

Based on these Functions one predefined operation is provided to invert the image content.

Execution and Clipping

Execution and Clipping

All integer operations are performed with long integers (4 byte) and are done in a way to minimize rounding errors (e.g. multiplication is done before division etc.).

During processing the result values are clipped to the limit of the data storage type which is

Data type	Lower	Upper
8 bit	0	255
16 bit unsigned	0	+65535
16 bit signed	-32768	+32767
32 bit	-2.147483.648	2.147483.647

Sometimes it is important the data limits of the camera are not exceeded. In this case the clipping is done to the intrinsic data limits of the camera which are

8 bit	0	255
10 bit	0	1023
12 bit	0	4095
13 bit	0	8191
14 bit	0	16383
16 bit	0	65535

To perform this type of clipping select the option Keep data type of camera data.

Predefined operations

Image processing > Arithmetic

Predefined operations

Predefined operations are operations on the image content which have well defined operators and constants. Currently there is only one predefined operation, it inverts the image data. If for example the image is a 12 bit image the inverted image is calculated by

$I_{new} = (4095 - I_{old})$

which leads zero for the highest intensity and 4095 for the lowest intensity. A similar effect can be achieved if the LUT option Invert is selected, with the difference that the LUT operation does not change the data whereas the processing functions changes the data.

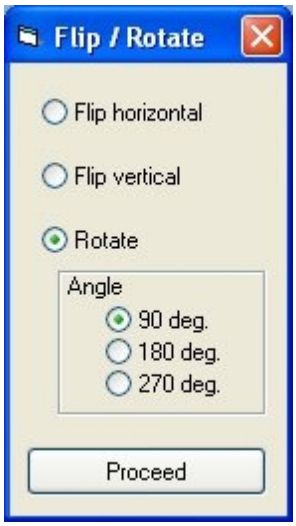
Flip and Rotate

Image processing

Flip and Rotate

The content of the image can be flipped horizontally and vertically and also rotated by 90, 180 and 270 degree. The operation is always applied to the currently selected image. If a sequence is selected the operation will be performed on all images of the sequence.

Choose **Flip/Rotate** from the **Processing** menu to display the Flip / Rotate dialogue.



To operate Flip or rotate select the desired operation and click Proceed.

Average

Image processing

Average

Average is a function which is based on an image or profile sequence. Please see the chapter Averaging for details.

Jitter correction

Image processing

Jitter correction

Jitter correction is a function which is based on an image or profile sequence. Please see the chapter Jitter Correction for details.

Creating data for special purposes

Creating data for special purposes

Tools are dialogs which are used to create special data which is used inside the program for different purposes.

Calibration file editor

Creating data for special purposes

Calibration file editor

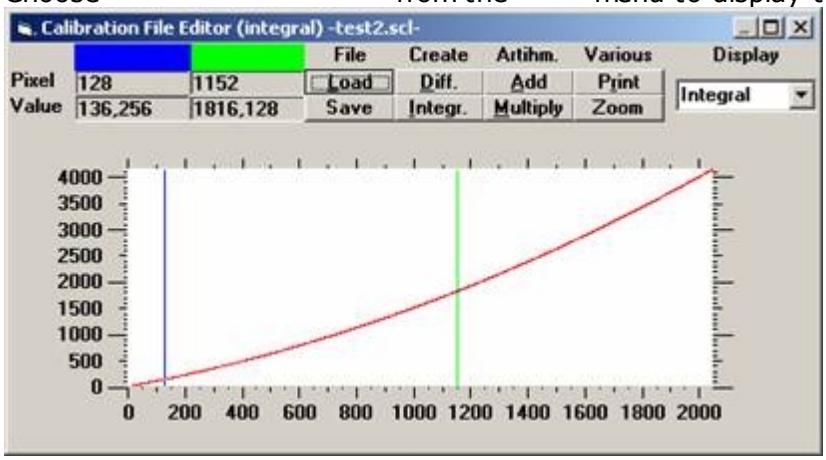
The calibration file editor tool is used to create, view and edit calibration files (tables).

Calibration files are files which contain floating point entries (old type calibration files contain 1024 or 1280 entries) in either ascending or descending order. They must be strictly

monotonous. They are used to assign calibration information to the system. Please see also the Appendix Calibration File Format for details.

If you want to add new calibration tables, be sure to have the necessary data (polynomial coefficients) prepared.

Choose **Calibration File Editor** from the **Tools** menu to display the Calibration File Editor.



Calibration File Editor

It displays the values of the floating point numbers as a graphical curve. The display can be either integral or differential. If the display is integral the values themselves are displayed. If the display is differential the differences of neighboring values are displayed. One can look at values by moving a cursor to a special location. Additionally the dialog shows the filename (if any) in the caption, the pixel number of the actually displayed value, the value itself in numerical form, and an indication whether the display is integral or differential.

The dialog contains the following pushbuttons

Title	Command	Function
File	Load	Loads a calibration file into the memory and displays it.
	Save	Saves the current set of data to a calibration file on disk.
Create	Diff.	Opens a dialogue where a set of calibration data starting from a differential polynomial can be calculated.
	Integr.	Opens a dialogue where a set of calibration data starting from an integral polynomial can be calculated.
Arith	Add	Adds a value to the polynomial.
	Multiply	Multiplies the polynomial with a value.
Various	Print	Print calibration file data.
	Zoom	Adjusts the zoom in a way that the data is fully visible within the Calibration Files editor s window.

File Load loads a calibration file into memory and displays it. This function automatically checks whether the specified file is a valid calibration file or not.

File Save saves the current set of data to a calibration file on disk. It is only enabled when valid calibration data are defined.

Create Differential Polynomial allows calculating a set of calibration data starting from a polynomial specifying the differences of data values.

Diff = A0 + A1*i + A2*i² + ...

A0: Coefficient 0
A1: Coefficient 1 etc.
An: Coefficient n (if the order of the polynomial is n)

If you push the **Create Diff.** pushbutton the dialogue **Create Differential Polynomial** is opened

To create a polynomial select the order of polynomial first. Then insert the coefficients. Finally press **OK** to confirm the data input.

Create differential polynomial

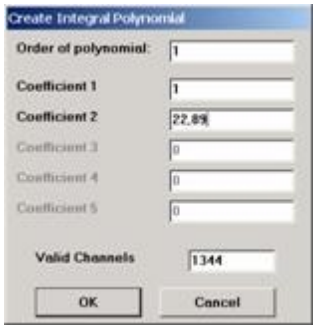
Create Integral Polynomial allows calculating a set of calibration data starting from a polynomial specifying the data values.

$$Value = \sum_{0}^{x} A0 + A1 \times i + A2 \times i^2 + \_$$

A0: Coefficient 0
A1: Coefficient 1 etc.
An: Coefficient n (if the order of the polynomial is n)

If you push the **Create Integr.** pushbutton the dialogue **Create Integral Polynomial** is opened

To create a polynomial select the order of polynomial first. Then insert the coefficients. Finally press **OK** to confirm the data input.



Create integral polynomial

The maximum polynomial order allowed is five for the integral and the differential polynomials.

Artih. Add Adds a value to the polynomial. If you click to the pushbutton Artih. A input box opens where the user can input a number. The number is added to the current values.

Artih. Multiply multiplies the polynomial entries with a value. If you click to the pushbutton Artih. Multiply an input box opens where the user can input a number. The polynomial entries are multiplied with this number.

A combo box labeled **Display** defines whether the calibration data is displayed in an integral (All items are displayed as they are) or a differential way (The difference of two adjacent entries is displayed).

By zooming with the right mouse button a part of the calibration data can be viewed

Curvature Correction Tool

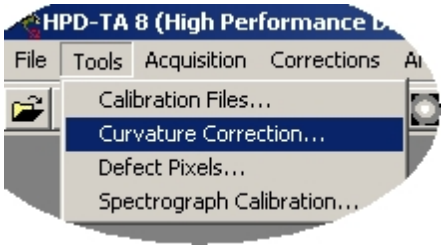
Creating data for special purposes

Curvature Correction Tool

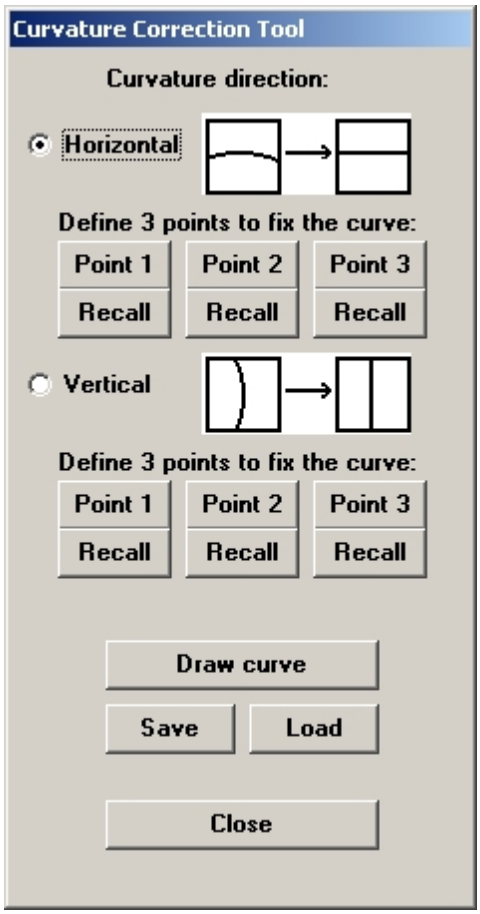
Note: *This chapter describes a function which is usually needed if you use a streak camera with synchroscan mode.*

In synchronous blanking mode of synchroscan operation the deflection of streak sweep is not completely straight, but elliptic. This results in a geometric distortion of the streak image in sweep direction. Curvature Correction corrects the distortion by compensating it with a parabolic correction curve.

To display the curvature correction tool execute the curvature correction menu command.



The Curvature correction tool is showed.



The Curvature Correction can be performed either in horizontal or in vertical direction. Choose the **Horizontal** method, if streak sweep is horizontal or **Vertical**, if sweep is vertical.

The geometric correction is done by using a parabolic correction curve. By specifying three

reference points the parameters of the parabola can be specified.

First, you have to acquire a streak image with a signal which shows the curvature distortion. Use this image to define the correction parabola.

To enter the location of the reference points click the push-button **Point 1** first and select a point on the left or upper position of the distorted curve and click the left mouse button. Repeat this with **Point 2** and **Point 3**. Point 2 should be in the centre and Point 3 at the lower or right side of the image.

Click **Recall** in order to resume the previous data.

When **Draw Curve** is clicked a correction curve is calculated and displayed, which interpolates the three selected points. You can re-adjust some of the selected points if the curve does not yet fit correctly to your distortion. Click at the corresponding **Point** button, readjust the reference point and draw it again by pressing **Draw Curve**. If you are satisfied with the curve click **Set.** The curvature data are stored in the system and will be used for curvature correction.

Save a correction setup by clicking the **Save** button. Load a previously saved correction set by clicking the **Load** button and selecting the desired file.

Defect pixel correction tool

Creating data for special purposes

Defect pixel correction tool

The defect pixel correction function corrects defective pixel of a sensor by replacing them with not defective neighbors. The Defect pixel correction tool allows creating defect pixel data. See also the chapter Defect pixel correction tool for details.

Spectrograph calibration tool

Creating data for special purposes

Spectrograph calibration tool

Spectrograph Calibration is used to assign spectral information to images acquired in combination with a spectrograph. The Spectrograph calibration tool is used create spectrograph calibration data. See also the chapter spectrograph calibration tool.

Programming techniques

Programming techniques

This topic deals with sophisticated programming techniques which can be used by expert users to extend the features of this software.

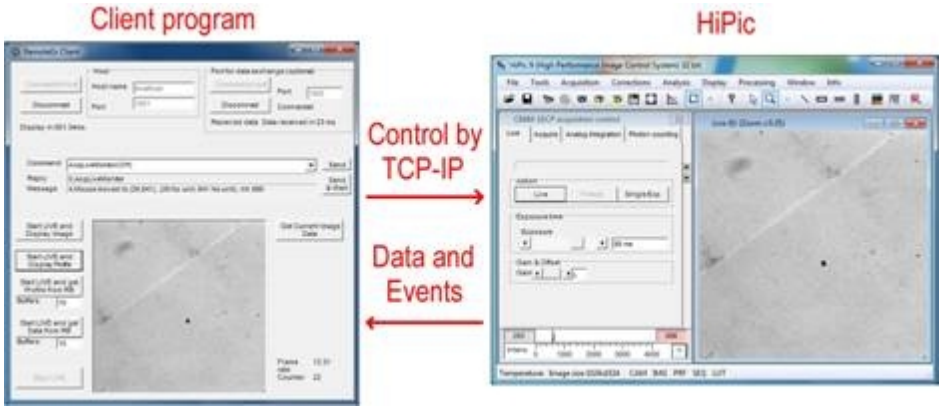
RemoteEx

Programming techniques

RemoteEx

RemoteEx allows to control the HPD-TA from another application via a text based communication which is exchanged by TCP-IP (see drawing). This allows to control the software from another application on the same computer or an application on another computer. The other application can also be based on a different operating system like UNIX

or Linux provided this operating system is able to communicate via TCP-IP. See the Remote Ex programmers Handbook in your application directory for details.



Script programming

Programming techniques

Script programming

The RemoteEx program also allows running script files to generate easily automated measurement cycles. Please see the Remote Ex programmers Handbook for details.

Accessing the CCD camera directly

Programming techniques

Accessing the CCD camera directly

The RS232 command can be used to watch or send control commands to a camera which is controlled by a serial command I/F. This feature is operable if the serial commands are transferred to the camera by a Windows COM port or by a dedicated com port of the frame grabber (like the Camera Link frame grabbers) It is mainly intended for diagnostics purposes and should not be used under normal circumstances.

If you choose **RS232** from the **Info** menu the Communication dialogue appears.

It shows the commands sent to the camera by the program and the response strings received from the camera.

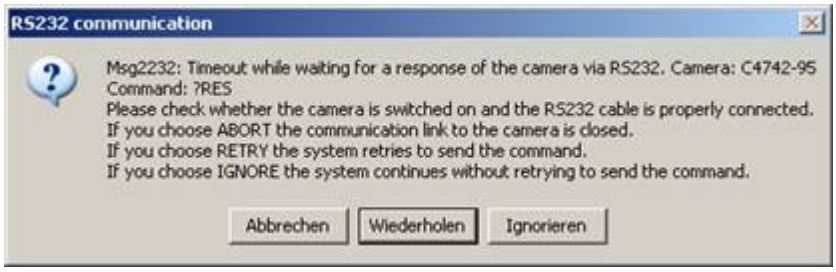
Also, the user can send commands to the camera manually (see the camera manual for details on the commands and their syntax). To send a command, write your command into the text box **Command to send** and push the **Send** button. The received response string is displayed in the display box **Received string**.

As long as the input focus is at the RS232 dialogue the user no longer can see commands sent and strings received in the meantime (Otherwise the user's commands would be permanently overwritten by the system's commands and could not be entered correctly).

Once the user sets the focus to another window the RS232 dialogue continues to display all system messages.

RS232 communication dialogue

If, at any time during program operation, there should be a time-out problem with the serial communication to the camera, the program will display the following **RS232 Timeout** dialogue.



RS232 Timeout dialogue

You can either select **Retry** to retry to communicate via RS232, **Continue** to continue the program without sending the command, or **Close** to close the communication link. When selecting **Retry** you can change to another COM port.

Appendix

Appendix

This chapter describes various technical aspects as file formats and other technical aspects of HPD-TA.

Image file formats

Appendix

Image file formats

The following describes the image file formats used in HPD-TA.

ITEX image (*.img format).

Appendix > Image file formats

ITEX image (*.img format).

This is one of the standard image formats (the other standard format is Data to TIFF image) which maintains the full information of all images and is compatible with all data processing functions of this program. If it is not intended to export image data to other programs, we recommend using this format.

Notes: If a camera with 16 bit data output is used, the image files will be saved in 16bit/ pixel format. Images saved in the 32 bit data format can not be loaded in software versions lower than 6.1.

The .IMG file format used in HPD-TA is compatible to the ITEX format.

Bytes	Content
0-1	Characters IM
2-3	Comment length (byte)
4-5	Width of the image in pixels
6-7	Height of the image in lines
8-9	X-Offset
10-11	Y-Offset
12-13	File type: 0=8 Bit, 1=Compressed (Not used), 2=16 Bit, 3=32 Bit
14-64	Reserved
64-nnn	Comment area containing the **status string**
nnn+1-End	Data Area (one or two bytes per pixel stored in row order from the top to the bottom of the image)

Note: If Table Calibration is used, the Calibration tables are stored after the end of this section. Please see the Appendix Status String Format for details.

TIFF format

Appendix > Image file formats

TIFF format

TIFF *(Tagged Image File Format) is a widely used image format and supported by most image-processing and word-processing software packages.*

The software also supports this file format. Two types of TIFF files can be generated.

TIFF images are stored using TIFF format version 6.0. When Calibration tables are used, these are appended to the normal data according to the status string which is saved in the comment tag.

Data to TIFF image

Appendix > Image file formats

Data to TIFF image

Data to TIFF image *allows to save image data with full data depth in TIFF format. The file will contain* ***8 or 16 bit*** *data without the LUT transformation.*

Note: Though 16 TIFF files are true TIFF files according to their definitions, not many other programs support this relatively new data format yet. If you are not sure whether your image analysis program can handle these files try it and use standard TIFF, as generated with the **Display to TIFF image** in the case your program cannot handle them.

Images stored in 32 bit format will be saved in 16bit/pixel format. Most upper 16 bits are used. Lower bits are skipped.

Note: If the current image is part of a sequence, you have the choice to save the full sequence or only the current image.

Display to TIFF image

Display to TIFF image

If ***Display to TIFF image* is selected,** *a (palletized)8 bit TIFF image will be saved.*

The function of this command is to create a TIFF file which **looks** exactly like the image which you see on the display screen, including contrast enhancement by the LUT. It does, however, **not** contain the full data bit depth of the image, and hence it should not be used to store measurement results for other than display purposes.

ROI overlay and QuickProfile will not be saved.

The TIFF image looks exactly like the image which you see on the monitor.

Note: If you want to load TIFF images within this program later on, always use the **Data to TIFF image** format.

Note: Display to TIFF will reduce the bit depth of the images!

If you want to store image data in another file format than IMG or TIFF, save them as TIFF first and use a graphic program (PhotoShop, Paint Shop Pro, Corel PhotoPaint) to convert the format.

Note: If the current image is part of a sequence, you have the choice, if you want to save the full sequence or only the current image.

ITEX Sequence

ITEX Sequence

This command allows saving a sequence of images which has been previously recorded with the ***Sequence*** *function*.

You have to choose the name for the first image in the sequence. The system will ***automatically*** name all other images. Sub-areas of images (ROIs) can be selected.

Note: There are two naming conventions for naming a sequence: NAMEXXX.IMG and NAME.**XXX** where XXX is a numeric expression (e.g. 001).

Select the file format ITEX Sequence (*001.img) to save a sequence in the format NAMEXXX.img.

Select the file format ITEX Sequence (*.001) to save a sequence in the format NAME.XXX. **Note**: This format may not be supported in future versions of this program. It is only provided for compatibility reasons with older program versions!

TIFF Sequence

TIFF Sequence

also supports TIFF file format for image sequences. Two types of TIFF file sequences can be

generated:

Data to TIFF Sequence

Appendix > Image file formats > TIFF Sequence

Data to TIFF Sequence

Data to TIFF Sequence *allows to save image sequence data with full data depth in TIFF format. The files will contain* ***8 or 16 bit*** *data without the LUT transformation.*

Note: Though 16 bit TIFF files are true TIFF files according to their definitions, not many other programs support this relatively new data format yet. If you are not sure whether your image analysis program can handle these files try it and use standard TIFF, as generated with the **Display to TIFF Sequence** in the case your program cannot handle them.

Images stored in 32 bit format will be saved in 16bit/pixel format. Most upper 16 bits are used. Lower bits are skipped.

The sequence will be recorded in the naming convention NAMEXXX.tif.

Display to TIFF Sequence

Appendix > Image file formats > TIFF Sequence

Display to TIFF Sequence

If **Display to TIFF Sequence** *is selected, 8 bit TIFF files will be saved.*

The function of this command is to create a sequence of TIFF files which **look** exactly like the images which you see on the display screen, including contrast enhancement by the LUT. They do, however, **not** contain the full data bit depth of the original images, and hence this format should not be used to store measurement results for other than display purposes.

Note: If you want to load TIFF images within this program later on, always use the **Data to TIFF image** format.

The sequence will be recorded in the naming convention NAMEXXX.tif.

Note: Display to TIFF will reduce the bit depth of the images!

If you want to store image data in another file format than IMG or TIFF, save them as TIFF first and use a graphic program (PhotoShop, Paint Shop Pro, Corel PhotoPaint) to convert the format.

ASCII image

Appendix > Image file formats

ASCII image

Image data can be saved in ASCII format. The data are stored without any header information. Each pixel data is separated by a TAB character. The end of each line is indicated by carriage return + line feed.

The data can not be read by this program. ASCII files can be read by many spreadsheet programs like Excel and data analysis programs like Origin.

The extension *.dat is used for indicating ASCII image files.

ASCII Sequence

ASCII Sequence

Image sequences can be saved in ASCII format using this format. The data are stored without any header information. Each pixel data is separated by a TAB character. The end of each line is indicated by carriage return + line feed.

The data can not be read by this program. ASCII files can be read by many spreadsheet programs like Excel and data analysis programs like Origin.

The naming convention NAMEXXX.dat is used for this file format.

HIS image sequence file

HIS image sequence file

The HIS format is used for image sequences acquired with the fast hard disk recording mode. A full image sequence is stored in one single file. Please refer also to.

Following is a detailed description of the HIS file format:

A) General

A) General

There are two types of headers (with almost identical format)

First header of every channel

Header describing all following images within a sequence

The content is:

1. First header of every channel

- Image format (width etc.)
- Channel number
- Number of images in the file
- Number of additional cannels
- Time stamp
- Marker

- Info about channel x (Comment string, variable length)

This header has variable length size (Length is determined by comment)

2. Header describing all following images within a sequence

- Image format (width etc.)
- Channel number
- Time stamp
- Marker

This header has variable length size (Length is determined by comment)

The header is always immediately followed by the data of one image.

B) Universal case

B) Universal case

1. First header of every channel

Bytes	Content
0-1	Character IM
2-3	Comment length in Bytes (ComLen)
4-5	Width of the image in pixels (iDX)
6-7	Height of the image in lines (iDY)
8-9	X-Offset (iX)
10-11	Y-Offset (iY)
12-13	File Type 1=8bit, 2=16bit, 3=32bit, 6=12bit[1)], 11=24bit RGB, 12=48bit RGB, 13=96bit RGB (not used now), 14=36bit RGB[1)]
14-17	Number of images in this file for this channel (-1=unknown)
18-19	Number of additional channels in the file
20-21	Channel number
22-29	Time stamp of image 0 (double)
30-33	Marker
35-64	Additional information (can be used freely by the application)
64 to 64 +ComLen-1	Comment area can contain any information. There is no restriction in lenght (except that a two byte variable is used for specifying the length). The HPD-TA stores a string in the format of an INI file and scaling tables here (if scaling is table type).

64+ComLen to 64 +ComLen +DatLen-1	Data of image

2. Header describing all following images within a sequence

Bytes	Content
0-1	Character IM
2-3	Comment length in Bytes (ComLen)

4-5	Width of the image in pixels (iDX)
6-7	Height of the image in lines (iDY)
8-9	X-Offset (iX)
10-11	Y-Offset (iY)
12-13	File Type 1=8bit, 2=16bit, 3=32bit, 6=12bit[1)], 11=24bit RGB, 12=48bit RGB, 13=96bit RGB (not used now), 14=36bit RGB[1)]
14-17	=0
18-19	=0
20-21	Channel number
22-29	Time stamp of image n (double). n is the index of the image coming after this header.
30-33	Marker
34-64	Additional information (can be used freely by the application)
64 to 64 +ComLen-1	Comment area can contain any information. There is no restriction in lenght (except that a two byte variable is used for specifying the length). The HPD-TA stores a string in the format of an INI file and scaling tables here (if scaling is table type).

64+ComLen to 64 +ComLen +DatLen-1	Data of image

Remarks:

1) 12 bit grayscale images and 36 bit RGB images are stored bit-packed with this setting

C) Standard case (one channel)

C) Standard case (one channel)

1. First header of every channel

Bytes	Content
0-1	Character IM
2-3	Comment length in Bytes (ComLen)
4-5	Width of the image in pixels (iDX)
6-7	Height of the image in lines (iDY)
8-9	X-Offset (iX)
10-11	Y-Offset (iY)
12-13	File Type 1=8bit, 2=16bit, 3=32bit, 11=24bit RGB, 12=48bit RGB, 13=96bit RGB (not used now), 14=36bit RGB
14-17	Number of images in this file (-1=unknown)
18-19	=0
20-21	=0
22-29	Time stamp of image 0 (double)
30-33	Marker
34-64	Additional information (can be used freely by the application)
64 to 64 +ComLen-1	Comment area can contain any information. There is no restriction in lenght (except that a two byte variable is used for specifying the length). The HPD-TA stores a string in the format of an INI file and scaling tables here

	(if scaling is table type).

64+ComLen to 64 +ComLen+DatLen-1	Data of image

2. Header describing all following images within a sequence

Bytes	Content
0-1	Character IM
2-3	Comment length in Bytes (ComLen)
4-5	Width of the image in pixels (iDX)
6-7	Height of the image in lines (iDY)
8-9	X-Offset (iX)
10-11	Y-Offset (iY)
12-13	File Type 1=8bit, 2=16bit, 3=32bit (not used now), 11=24bit RGB, 12=48bit RGB, 13=96bit RGB (not used now), 14=36bit RGB
14-17	=0
18-19	=0
20-21	=0
22-29	Time stamp of image n (double). n is the index of the image coming after this header.
30-33	Marker
34-64	Additional information (can be used freely by the application)
64 to 64 +ComLen-1	Comment area can contain any information. There is no restriction in lenght (except that a two byte variable is used for specifying the length). The HPD-TA stores a string in the format of an INI file and scaling tables here (if scaling is table type).

64+ComLen to 64 +ComLen+DatLen-1	Data of image

Profile File Format

Appendix

Profile File Format

The format of the profiles files written by HPD-TA is as follows:

```
;"HiPic 6.2 Profile"                                          1.)
;"HiPic,5.0,1,4.0,3,6,3,3,373,3868,1,01-28-1994..."          2.)
;585,70,799,411                                               3.)
;342,0,3                                                      4.)
;1,1.515152,"ps        ","scal1    "                         5.)
0,357.4605
1.515152,360.8232
3.030303,354.1535
4.545455,352.8047
```

1) Identification line (contains ;"HiPic 6.2 Profile").
2) Status string in "", preceded by semicolon.
3) Start and end position of the profiles in the form:
   StartX, StartY, EndX, EndY. For Integrated profiles it indicates the position of two opposite corners of the rectangle used for integration, preceded by semicolon.
4) Number of data points, X-Offset (always 0) and Profile Type:
   1=line, 2=Integrated horizontal, 3=Integrated vertical, preceded by semicolon.
5) Calibration Type (1=Linear, 2=Table), Calibration Factor (linear Calibration only), Unit in "", Calibration file without extension (table Calibration only), preceded by semicolon.
6) Data in subsequent lines, as many lines as number of data points. Format: X, Y value

Calibration File Format

Appendix

Calibration File Format

Calibration files are used to provide nonlinear or special Calibration. They contain a list of floating point numbers (4 byte type, called float or single). Each number corresponds to one pixel on the chip. The Calibration file does not contain a unit nor the information for which direction the Calibration is applied. Calibration files must always have the extension **.SCL**. The floating point numbers must be strictly monotonous (ascending or descending), otherwise the file is not accepted by the system as a valid Calibration file. The format of the file is as follows:

Bytes 0-3	Value 0
Bytes 4-7	Value 1
Etc.	Etc.
Bytes n*4 - Bytes n*4+3	Value n

Note: The Calibration data is directly written to the image file if the Calibration type is table. The tokens ScalingXFile and ScalingYFile contains an address where the Calibration table is written in the file. An asterik * or a plus + indicates the address. The asterik indicates that the Calibration has 1024 entries, the plus indicates 1280 entries. If it contains e.g. the entry *473533 the Calibration data is written in the image file at an offset of 473533 bytes. The format #xxxxxxx,yyyy means the table with yyyy entries and address xxxxxxx.

DPC File Format

Appendix

DPC File Format

Dynamic photon counting images are saved in the DPC file format. In a DPC file the x-y coordinate of each photon and the time when it has been detected are recorded.

Bytes	**Content**
0-1	Characters IM

2-3	Comment length in bytes (ComLen)
4-5	Width of the image in pixels (iDX)
6-7	Height of the image in lines (iDY)
8-9	X-Offset (iX)
10-11	Y-Offset (iY)
12-13	File type: 2=16 Bit
14-64	Reserved
64-nnn	Comment area can contain any information. It is used by the program to store the status string and the Calibration tables (if any)
nnn+1-End	Data Area (Starts at address 64+ ComLen)

The **Data Area** looks like n times the following diagram, where there is one set of such data for every frame. The first entry is the time stamp relative to the origin in ms, followed by a the coordinates of all photons counted within this frame. The end of the data for the first frame is indicated by a delimiter (0xFFFFFFFF). This is repeated for all frames recorded.

Byte	Coordinates	Remark
00-03	Timestamp	Time in ms from first image (long int)
04-05	X0	Photon 0, X-Coord.
06-07	Y0	Photon 0, Y-Coord.
08-09	X1	Photon 1, X-Coord.
10-11	Y1	Photon 1, Y-Coord.
Etc.	Etc.	Etc.
Etc.	Etc.	Etc.
20-24	0xFFFFFFFF	Delimiter (Long int, all bits set to 1)

DPT File Format

Appendix

DPT File Format

The DPT file is basically the same as the DPC format. The DPT format is used for photon correlation measurement, where the photons are detected along predefined traces within the image. The meaning of the x-coordinate of every photon within a DPT file is not the real x-coordinate as it is the case for DPC files, the meaning is the trace number instead.

Status String Format

Appendix

Status String Format

The status string is a string which is attached to an image and to profiles derived from an image. It contains all information about the image. The following is a sample string and the description of the different information. The status string contains only ASCII strings separated by comma. If the token Enconding=UTF-8 in the section [Application] exits, the encoding is UTF-8 which means that this string can contain characters from the Unicode character including Japanese characters and other country specific characters.

The image status is saved as one string and it is organized like a *.INI file. It contains different sections where every section can contain tokens with assigned values. Other

programs like remote control client programs or just any different image processing programs can add their own sections to save special data without disturbing the HPD-TA. It is, however, important to know that several of the entries in the status string are mandatory. Otherwise the file cannot read by the programs correctly. So be careful if you modify any of the tokens mentioned here. This is especially important for the Sections [Acquisition] and [DisplayLUT].

As an example we take the following status string (It was created when acquiring an image from the C9300-221 camera):

[Application],Enconding=UTF-8,Date="06.10.2010",Time="10:28:01.793",Software="HiPic",Application=1,ApplicationTitle="High Performance Image Control System",SoftwareVersion="9.0",SoftwareDate="15.09.2010"

[Camera],AMD=N,NMD=T,EMD=E,SMD=N,ADS=12,SHT=1,FBL=1,EST=1,SHA=K,SFD=F,SPX=2,TNS=1,ATP=N,CEG=0,CEO=0,ESC=I,SHO=160,SHW=0,SVO=0,SVW=0,TimingMode="Internal timing",TriggerMode="Edge trigger",TriggerSource="Digital I/F",VerticalBinning="1",TapNo="1",TriggerPolarity="neg.",CCDArea="1024 x 1024",Binning="2 x 2",ScanMode="Normal",SubarrayHOffs=160,SubarrayHWidth=0,SubarrayVOffs=0,SubarrayVWidth=0,NoLines=1024,TriggerDelay=0,CameraName="C9300-221",Type=29,SubType=46

[Acquisition],NrExposure=1,NrTrigger=0,ExposureTime=20 ms,AcqMode=1,DataType=3,DataTypeOfSingleImage=3,CurveCorr=0,DefectCorrection=0,areSource="0,0,640,480",areGRBScan="0,0,640,480",pntOrigCh="0,0",pntOrigFB="0,0",pntBinning="1,1",BytesPerPixel=2,IsLineData=0,BacksubCorr=0,ShadingCorr=0,ZAxisLabel=Intensity,ZAxisUnit=Count

[Grabber],ConfigFile="D:\Visual Studio 2008 Projekte\HiPic90\HiPic90.NET Ver03\bin\Hamamatsu_DCAM.pcf",Type=7,SubType=3

[DisplayLUT],EntrySize=3,LowerValue=0,UpperValue=4095,BitRange="12 bit",Color=2,LUTType=0,LUTInverted=0,DisplayNegative=0,Gamma=1,First812OvlCol=1,Lut16xShift=0,Lut16xOvlVal=32767

[Scaling],ScalingXType=1,ScalingXScale=1,ScalingXUnit="No unit",ScalingXScalingFile="No calibration",ScalingYType=1,ScalingYScale=1,ScalingYUnit="No unit",ScalingYScalingFile="No calibration"

[Comment],UserComment=""

The name of every section is enclosed in brackets []. Every token is separated from its value with a "=" character. The tokens are separated from each other with comma. After one section there can be a Carriage Return Line Feed combination, but this is optional.

As an example we take the "SoftwareVersion" token with the "Application" section. It's value is "9.0". The value can be enclosed by quotes if necessary, but this is optional. Lets take the "EntrySize" token from the "DisplayLUT" section. It's value is "3" (But no quotes are used). When quotes are used the value can even contain commas like the "pntOrigCh" token within the "Acquisition" section. Section and token names are case sensitive which means "camera" and "Camera" are different.

LUT

Appendix

LUT

There are three types of LUT: Linear LUT, gamma LUT and sigmoid LUT.

Linear LUT (default)

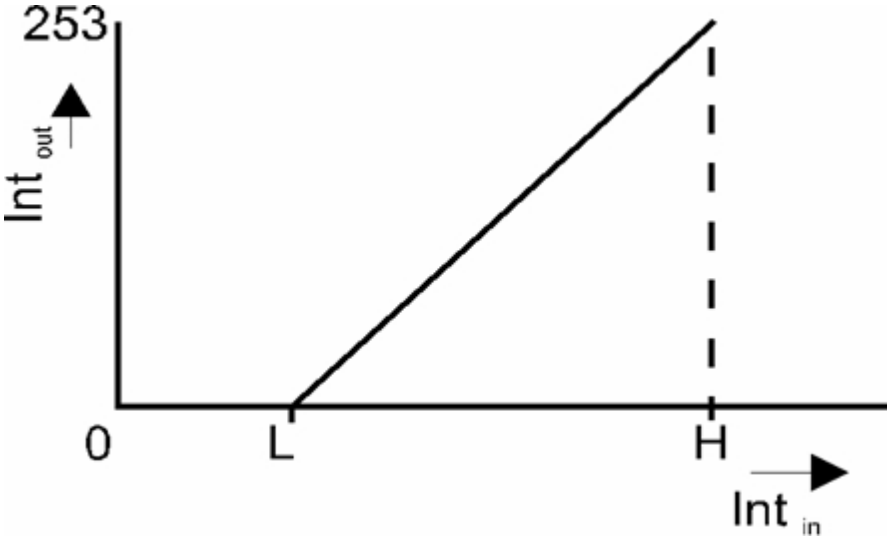
Appendix > LUT

Linear LUT (default)

This LUT makes a linear grayscale transformation between the input image data and the

displayed data.

$$Int_{out} = \frac{Int_{in} - L}{H - L} * 253$$



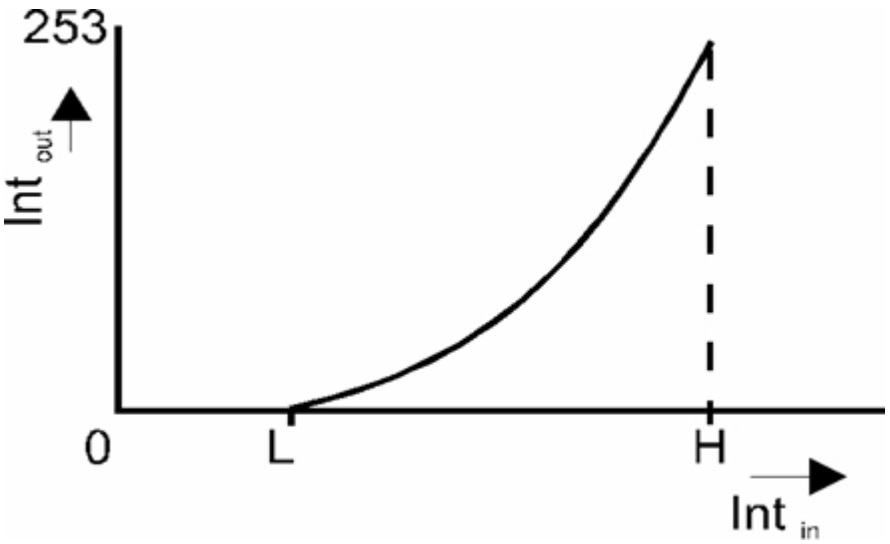
Gamma LUT

Appendix > LUT

Gamma LUT

This LUT makes a nonlinear grayscale transformation according to following algorithm:

$$Int_{out} = \left[\frac{Int_{in} - L}{H - L}\right]^{k} * 253$$



Sigmoid LUT

Appendix > LUT

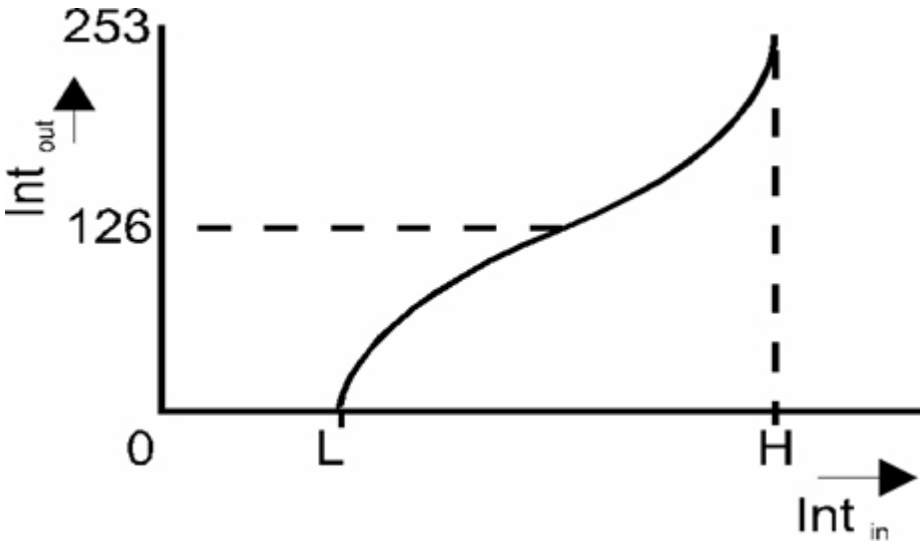
Sigmoid LUT

This LUT makes a nonlinear grayscale transformation according to following algorithm:

$$Int_{out} = \left[\frac{Int_{in} - L}{\frac{H - L}{2}} \right]^{k} * 126 \quad \text{for} \quad Int_{in} < \frac{H - L}{2} + L$$

and

$$Int_{out} = 253 - \left[\frac{H - Int_{in}}{\frac{H - L}{2}} \right]^{k} * 126 \quad \text{for} \quad Int_{in} \geq \frac{H - L}{2} + L$$



Error handler

Appendix

Error handler

Though the program is carefully designed, planned, coded, tested and debugged, software which exceeds a certain amount of code cannot be absolutely bug free in every circumstances and with all available parameter settings. As a consequence this program also may have certain bugs which are not detected during test but which may appear at customers site. To allow easy debugging and ensure program quality a powerful error handler has been established within this program. When a fatal error occurs the chain of function calls and other important data is written to a file before the program is ending. This file can be used to locate the origin of the error as quickly as possible.

When such an error occurs a message-box appears informing the user that such an error has appeared and all information has been written to the file **ERRORS. TXT** within the directory in which the programs EXE file is located. If such bug has occurred at your side please send this file to your local **Hamamatsu** dealer.