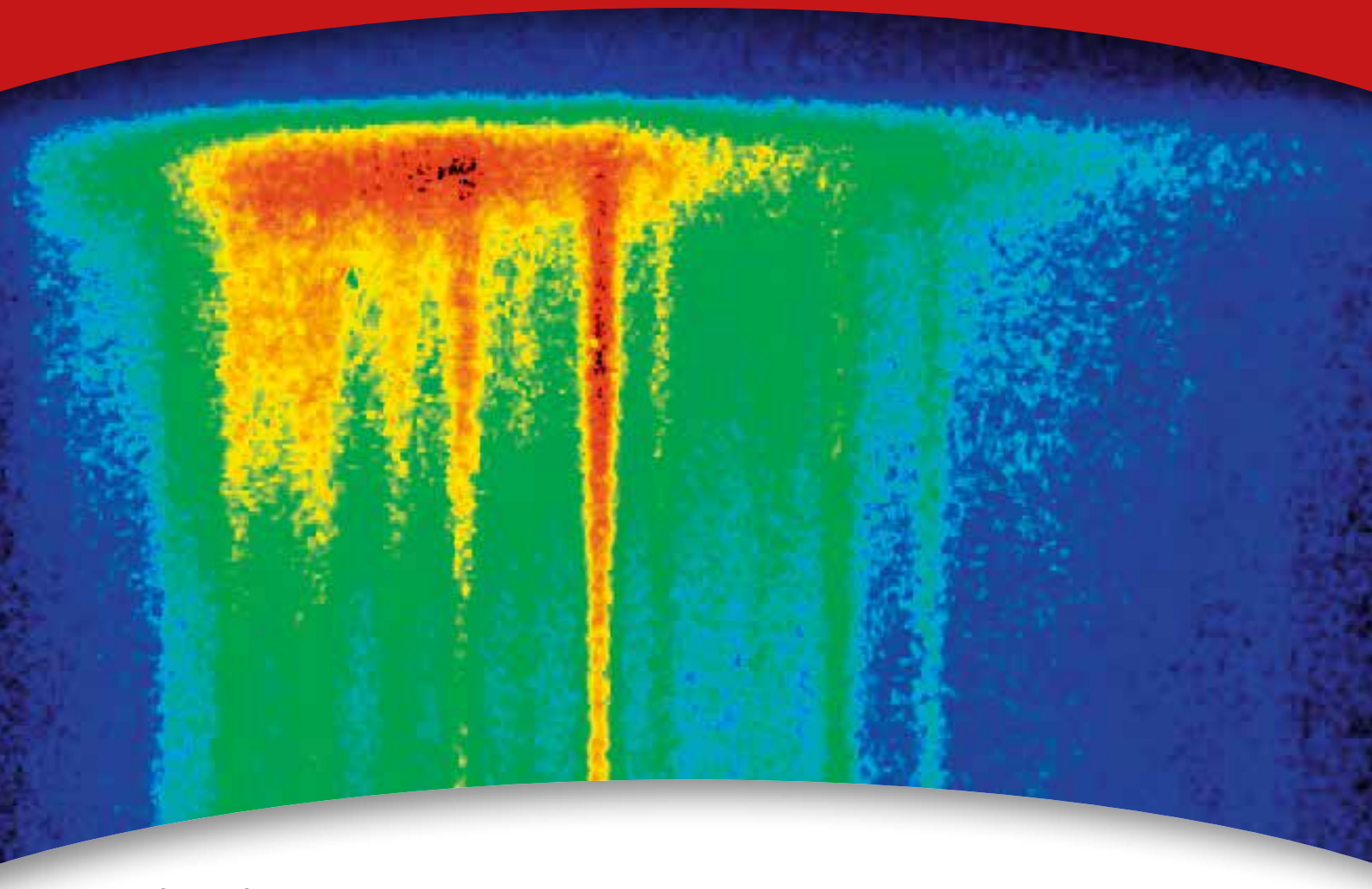
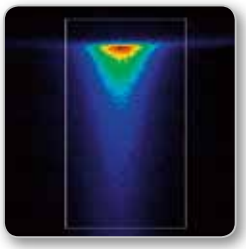
HPD – TA

High-Performance Digital Temporal Analyzer



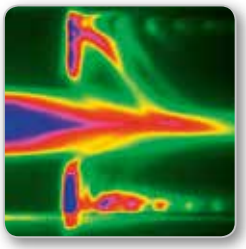
Software for streak camera systems, U13313

- Control of complete streak systems
- Powerful data acquisition
- Full data calibration
- Manual and automated operation

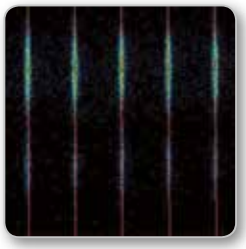


Fluorescence spectroscopy

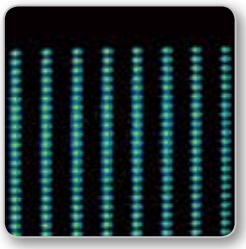
Laser physics



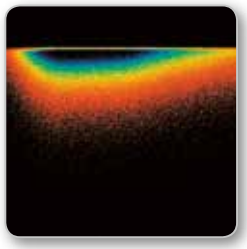
Plasma physics



Photon correlation



Synchrotron monitoring



X-ray excited luminescence

HAMAMATSU

PHOTON IS OUR BUSINESS

Overview

The HPD-TA Temporal Analyzer system is a high-performance control & imaging system, designed specifically for controlling streak systems and performing streak measurements in a wide variety of application fields. It provides precise data acquisition and preprocessing of two-dimensional streak data, including a full range of data correction and calibration possibilities.

It integrates the various hardware devices belonging to a complete streak measurement setup into a single coherent system by controlling all system components and their interrelations.

The HPD-TA software runs on current Microsoft Windows platforms, 32 bit and 64 bit versions. It offers plenty of features based on our long-term experience and feed-back from users all over the world.

Streak camera control

Delay control

Spectrograph control

The device support is realized via "virtual devices", i.e. software modules that mirror the real devices. This is a modular design using driver plug-ins, which allows us to add new devices easily.

The user interface is realized via standardized control panels that look similar for all devices. These control panels facilitate controlling the hardware as well as displaying the current device status. The examples above show the control panels of a streak camera, a spectrograph and a delay generator.

Supported hardware

Streak cameras	HPD-TA fully supports all Hamamatsu streak cameras models, old and new ones. Several safety functions help to prevent overstressing the streak tube in case of user mistakes. In this way HPD-TA brings not only convenience but also safety to your valuable system.
Readout cameras	For reading out the phosphor screen of the streak tubes HPD-TA supports many models of Hamamatsu digital cameras, the most common ones shown on the last page. All main features of these cameras are fully supported. The software performs real-time image data transfer to the PC and real-time data processing functions.
Accessory devices	Besides these core devices, HPD-TA can also control a variety of other external devices that are frequently used in streak setups, such as spectrographs, pulse generators, delay generators, trigger units, shutters, and more. (For a detailed list of currently supported devices, please consult Hamamatsu.)

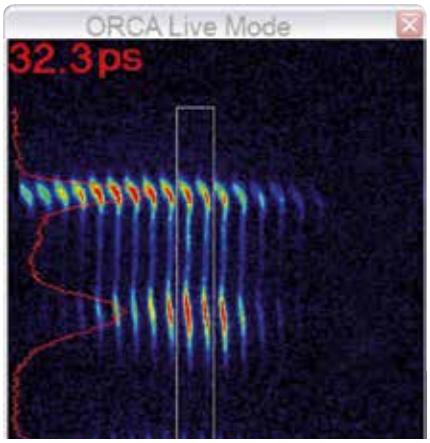
This versatility allows enrolling all these devices into a single coherent measuring system, convenient and safe to use. Streak measurements have never been easier.

Data acquisition

Live imaging

Live Mode allows viewing the streak image on the PC monitor in real-time. It is mainly used for monitoring the light signal during jobs such as optical alignment, focusing, laser adjustment, and so on.

The example picture shows the time-resolved spectrum of a pulsed laser diode in real-time.



Event synchronization

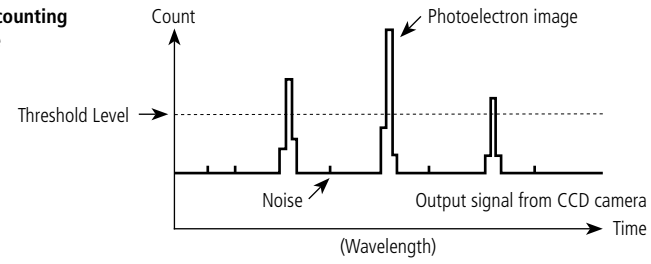
In case of single-sweep streak setups the image grabbing must typically be synchronized with the streak camera and external events. HPD-TA supports versatile trigger schemes facilitating this task, including handshake signaling with the streak camera in order to control trigger inhibition and to prevent accidental misfiring.

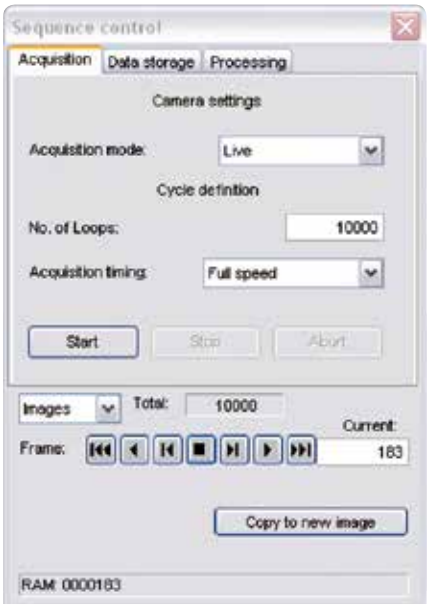
Ultra-sensitive data acquisition

The measurement of very weak signals frequently requires longer integration times. HPD-TA offers a wide variety of integration modes, including on-chip integration and in-memory accumulation. By these methods, integration times ranging from a few ms to several hours can be realized.

If ultimate sensitivity or dynamic range is required, the user can choose *Photon-Counting Mode*. This yields near-Poissonian counting statistics, and the obtainable D-range has basically no upper limit. All kinds of data integrations are performed in real-time, without skipping any signal.

Photon-counting principle

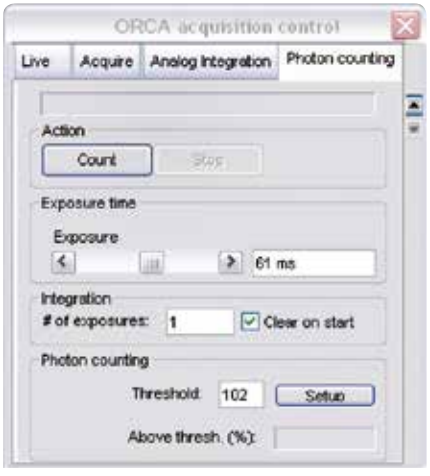


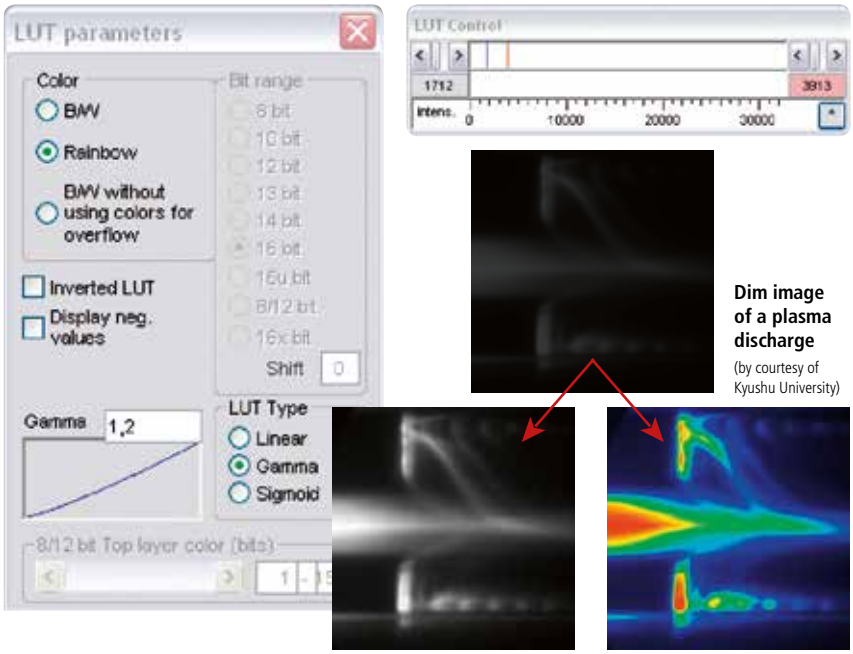


Recording dynamic phenomena

For the purpose of recording slow variations of streak data over time, HPD-TA offers two dedicated tools. *Sequence Mode* streams images or intensity profiles continuously into RAM or onto the hard disk in real-time. After recording, such sequences can be played back like a movie, and various image processing functions can be applied to the sequence at once, including averaging and jitter correction.

Dynamic Photon Counting records only the X-Y coordinates of photons. This allows extremely long data integration with a minimum of data size while preserving the exact coordinates of each registered photon. For example, the change of a time-resolved picosecond photon-counting spectrum due to slow sample kinetics can be analyzed. Also, post-selection of data ranges is possible without the need to repeat a whole long measurement from scratch.





Dim image of a plasma discharge
(by courtesy of Kyushu University)

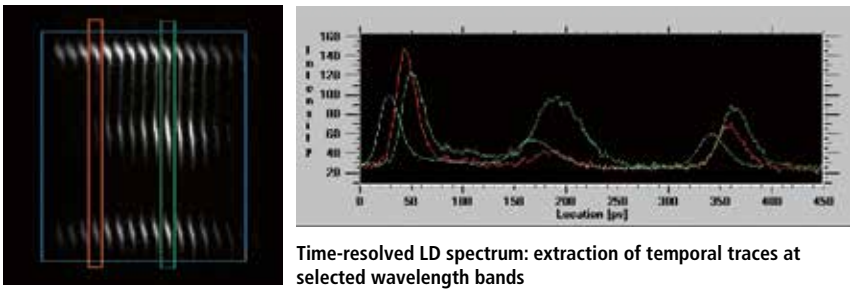
With contrast enhancement

With pseudo colors

Image display

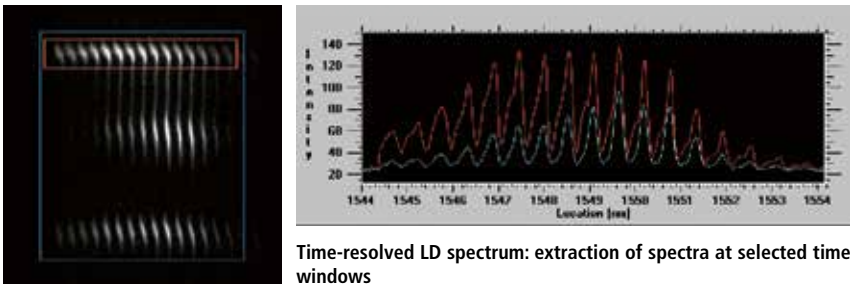
Frequently, images are very faint due to very low signal levels, which makes them difficult to inspect visually. The look-up-table (LUT) tool provides easy control over the image appearance by adjusting brightness, contrast and pseudo-colors, without affecting any measurement data. By this means even the dimmest phenomena can be visualized clearly and brightly. Image zoom & scroll allow inspecting tiny details when desired.

All these features work in real-time and in all acquisition modes including Live mode.



Time-resolved LD spectrum: extraction of temporal traces at selected wavelength bands

Vertical profile windows yield the temporal intensity traces. The red and green trace are the profiles of only one laser diode mode respectively, while the blue trace sums over all wavelengths.



Time-resolved LD spectrum: extraction of spectra at selected time windows

The red trace shows the spectrum of the leading pulse only (equivalent to gated spectroscopy with a gate time of only a few ps), while the blue trace sums over the whole time span (equivalent to steady-state spectroscopy).

Intensity profiles

After acquiring a streak image you will usually want to extract intensity profiles along the time axis or the orthogonal axis. These profiles are created by integration inside of regions of interest (ROIs).

HPD-TA can handle several such profiles simultaneously, displayed in different colors. Simple analytical parameters like peak, rise/fall time, FWHM and others can be obtained on the fly.

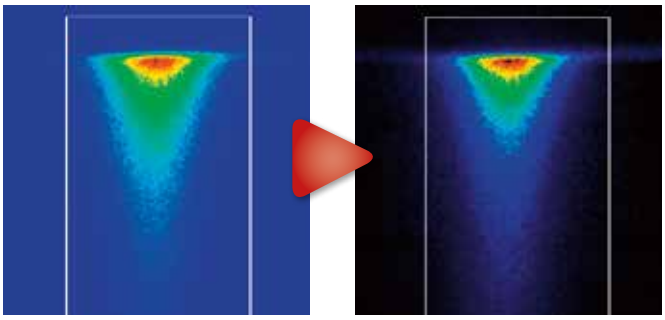
Examples on the left show how two different kinds of results can be extracted from one single streak image. The image is the same as that on page 3 under Live Mode, but now it has been frozen in memory.

Data correction

HPD-TA offers a full range of data correction and pre-processing functions. These are used to eliminate data artifacts caused by the characteristics of the experimental setup and measuring apparatus.

Background correction

Background correction is a subtractive correction eliminating offset signal caused by camera dark current or any other unwanted background signal such as stray light.



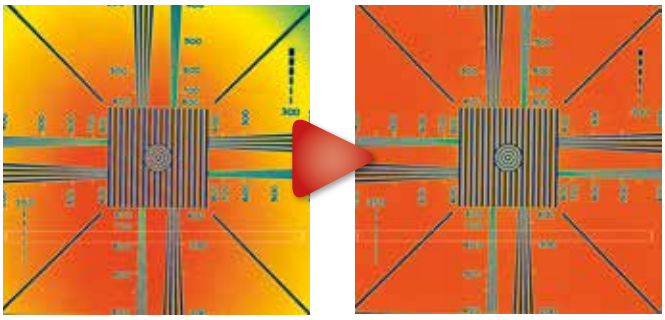
Time-resolved fluorescence spectrum

After background subtraction

Shading correction

Shading correction is a multiplicative correction compensating for overall system non-uniformities such as those caused by photocathode shading or imperfect optical components in the measurement system.

A sub-case is spectral sensitivity correction, which is used in time-resolved spectroscopy and compensates for the wavelength-dependent efficiency of the spectrograph and detector.

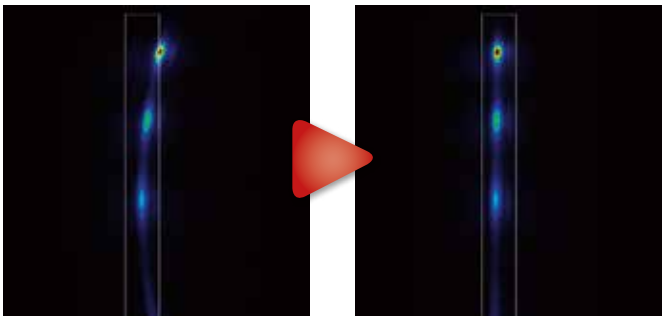


TV test pattern

After shading correction

Curvature correction

Curvature correction performs a geometric image correction. Its main use is in combination with synchronous blanking, a special mode of synchroscan operation, which is causing an elliptical distortion of the streak image. Curvature correction allows you to rectify such images.

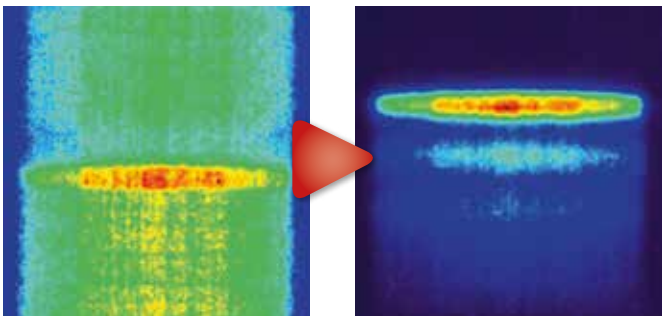


Oscillating laser diode

After curvature correction

Jitter correction

In some cases, especially repetitive single-shot operation, simple data accumulation sometimes does not give satisfying results due to timing jitter between subsequent data records. The Jitter corrector can automatically determine individual timing shifts for each data record prior to accumulation, thereby eliminating signal broadening. Jitter correction is used in combination with the sequence functionality.



Oscillating LD, integration with large jitter

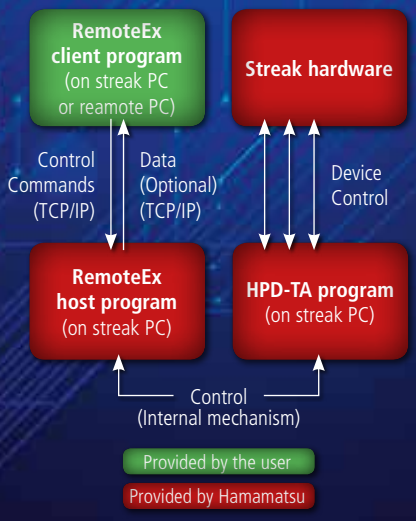
After jitter correction

Major data formats:

2-D data (images):
- IMG format (HPD-TA default format, up to 32 bits/pixel)
- TIFF format (mainly for presentation, publishing, printing)
- ASCII format (for easy import into data analysis software, spreadsheets, etc.)
- Two different image sequence formats (IMG file collection; HIS container)

1-D data (profiles):
- ASCII format, 2-columns (for easy import into data analysis software, spreadsheets, etc.)

All data formats are fully documented in the extensive user manual.



RemoteEx and LabVIEW SDK are well documented by extensive user manuals.

Data calibration

HPD-TA automatically attaches calibration information to all measurement data. Both image axes can be calibrated, the time axis and the orthogonal axis (which may be a wavelength axis if the streak camera is used in conjunction with a spectrograph).

Usually, the time calibration of a streak system is predefined by the factory, but the user can define new calibrations easily if he wants. After setup, all calibration handling by the system is fully automatic and does not require any special attention by the user.

Data export

Frequently, users wish to access measurement data by external software for special analysis or display purposes. Hamamatsu has been careful to make such tasks as easy as possible. HPD-TA supports popular file formats for images and profiles.

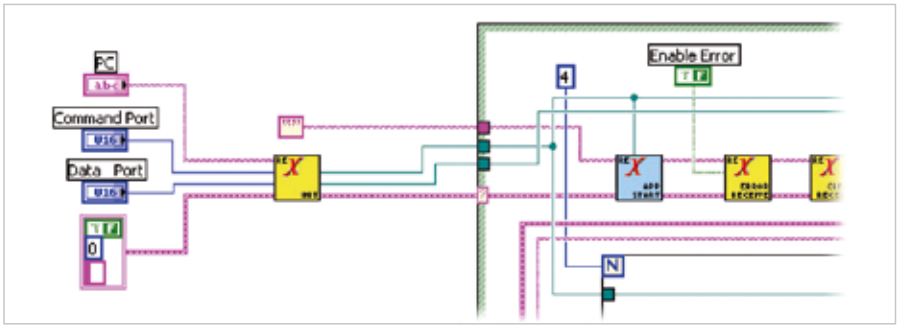
Remote control, automation & customization

In some cases it is desired to control the streak system by a user-written program or from a remote computer in the LAN. For instance, you may want to integrate the streak system into a bigger lab measurement scheme, or you may wish to create your own customized control software for special purposes. Also in some cases, the streak system may be physically inaccessible due to hazardous local environment, and so needs to be completely remotely controlled.

RemoteEx
The remote-control scheme called "RemoteEx" is the solution for all such cases. It works in a very simple manner by sending ASCII text commands to the streak system via TCP/IP, either from the streak PC itself or from any other computer on the LAN. These commands act on a high level, so you don't need any detailed knowledge of the interiors of the involved hardware. This also ensures that some convenient automatic functions of the HPD-TA software are still active, which makes your own control code easy and safe.

Measurement data (profiles and images) can be transmitted as well. There are no restrictions on the programming language you use to write your control code, and it may run on any computer platform and operation system. The only requirement is that TCP/IP is available.

LabVIEW SDK
If you prefer to use LabVIEW for your automation tasks we offer a complete "vi" framework, ready to use. Sample LabVIEW programs are included.



Application-specific modules (optional)

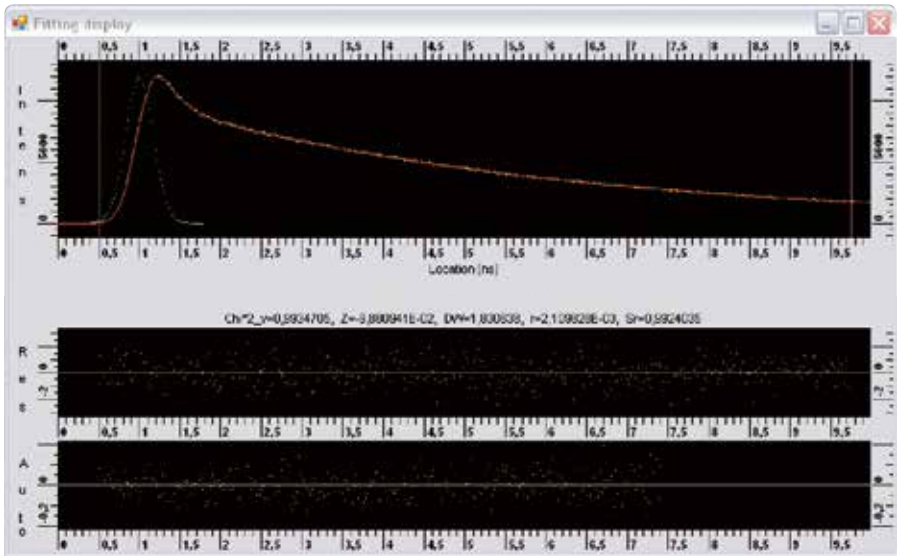
Some application-specific add-on modules for the HPD-TA software are available as options. They are seamlessly integrated into the HPD-TA and can be used without leaving the main program.

TA-Fit: Module for fluorescence lifetime data fitting

This is a tool for quantitative analysis of the intensity profiles from fluorescence decay emissions.

Features

- Fitting engine with adaptive least-square fitting algorithm
- Optional deconvolution with excitation pulse
- Determination of multiple lifetime components
- Quality of fit control via residuals, chi-square, autocorrelation
- Easy tweaking of fit parameters
- User-defined fitting sets for quick access to previously used settings



Fitting display window

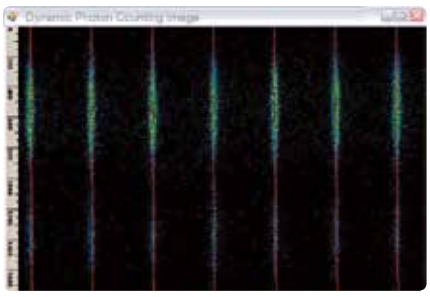
Fitting control window

Data fitting is a job that usually requires some level of training. Our extensive user manual not only explains the practical usage of the software, but also illuminates the theoretical background and contains a step-by-step tutorial.

TA-Correlation: Tool for photon correlation measurements

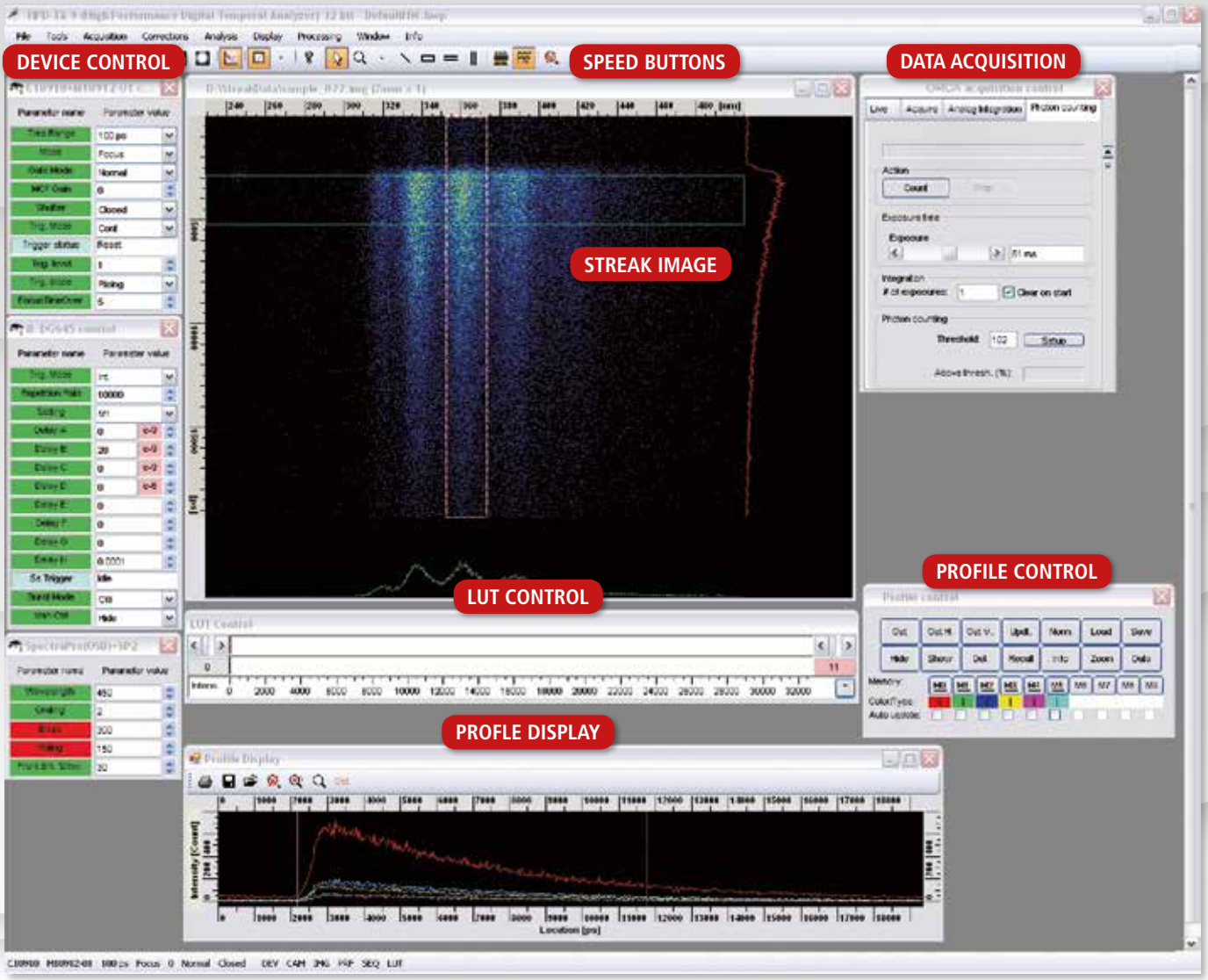
This is a module for users who use their streak system for recording photon correlation data, an important subject in quantum optics and nanosciences. Advantages of the streak method are the very high temporal resolution, no obstruction from detector dead times, and the possibility to calculate also correlation functions of higher orders.

This module is using Dynamic Photon Counting to record the coordinates of each single photon, and makes these data accessible to the user's own analysis in a very easy way.



Photon correlation measurement

Typical workspace



Popular readout cameras

Features	Model C10600-10B ORCA-R2® Digital CCD Camera Suitable for most applications	Model C9300-508 High-speed Digital CCD Camera Optimized for rapid photon-counting	Model C11440-22CU ORCA-Flash4.0 V2 Digital CMOS Camera High-grade camera ideally suited for most applications
Resolution	1344 x 1024 pixels	640 x 480 pixels	2048 x 2048 pixels
Frame rate	typ. 28 Hz (depends on mode)	max. 150 Hz	typ. 150 Hz (depends on mode)
A/D conversion	12 bit / 16 bit	12 bit	16 bit
TE-cooled	yes	yes	yes

Other camera models may be available on request. Please consult with Hamamatsu.

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