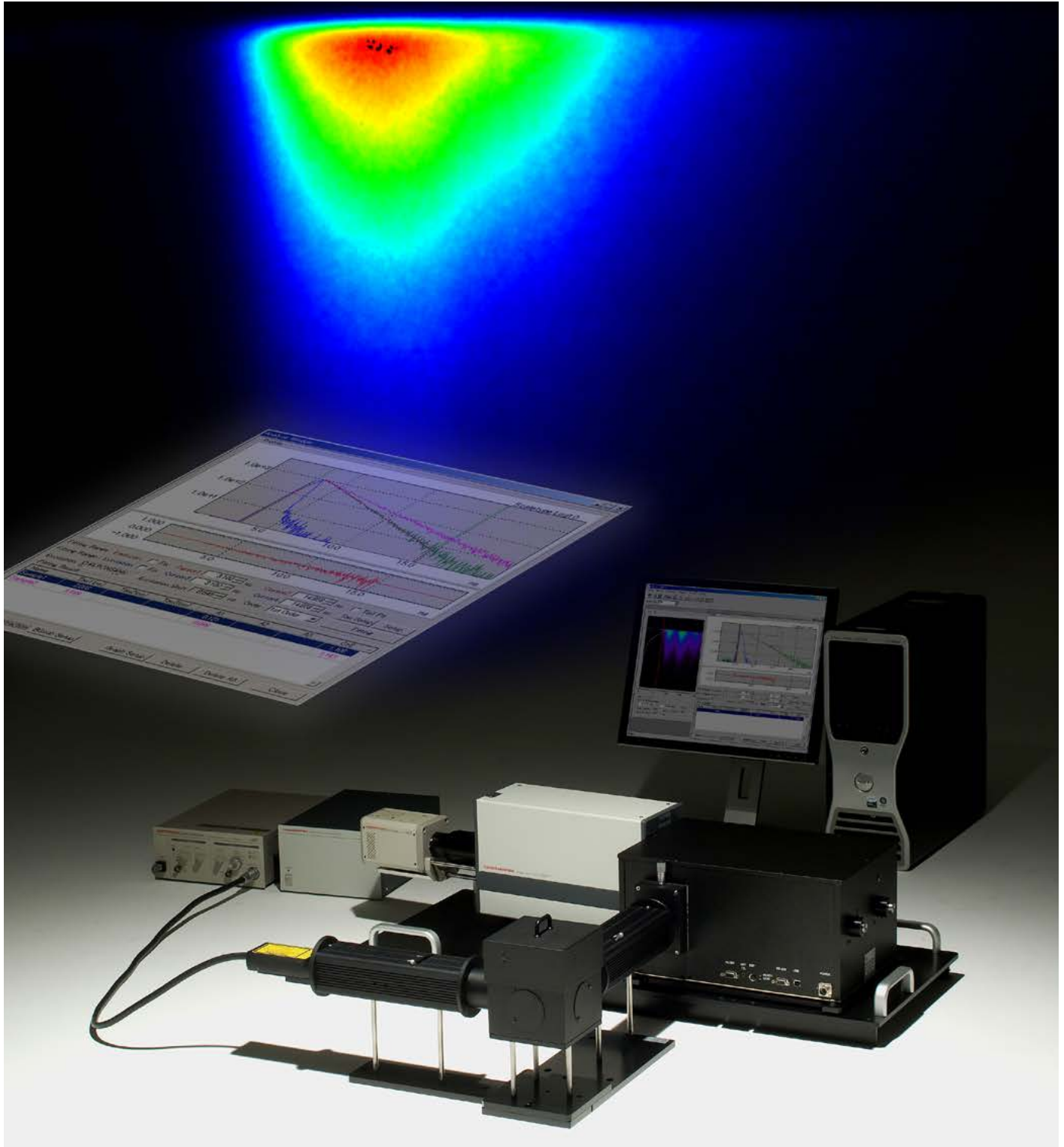
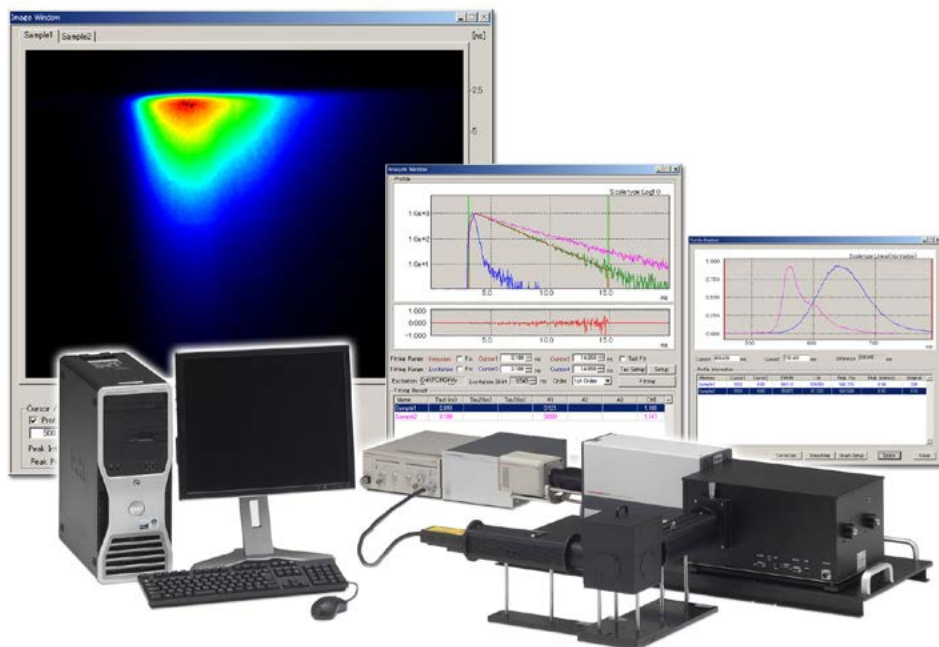


Picosecond fluorescence lifetime measurement system C11200

Captures fluorescence phenomena with 5 ps temporal resolution using 2D photon counting method. Enables simultaneous fluorescence lifetime analysis and time-resolved spectrophotometry.





Directly captures temporal variations of laser-excited fluorescence with 5 ps resolution.

Photoluminescence which is represented by fluorescence, phosphorescence, or delayed fluorescence is one of the energy release processes to be observed when molecules return from the excited state to the ground state.

Measurement of photoluminescence decay with an ultra-fast pulsed excitation light is generally called as fluorescence lifetime measurement and studied to reveal various dynamics of excited molecules.

Recently, development of various kinds of materials such as organic/inorganic phosphors, compound semiconductors, and quantum dots are getting more prosperous and are put into practical uses in the fields of the most advanced technologies such as OLED, LED, solar cell, and applied biology. The photoluminescence lifetime measurement is very important technique to improve the performance or efficiency of these materials.

The Hamamatsu Picosecond fluorescence lifetime measurement system has been developed in response to the requirements from researchers studying such materials. The streak camera, an optical time recorder with picosecond time response, makes it possible to study ultra-fast time-resolved spectrophotometry. The streak camera technology allows detection sensitivities in the photon counting region. For simultaneous measurement of time and wavelength, a spectrometer can be added to the system. The streak camera system is controlled by a designated software with high operation performance.

Applications

- Study of initial stages of photophysics and photochemistry
- Study of microscopic environments and dynamic structures of surfaces and interfaces
- Study of dynamic structures of 2D molecular aggregates such as macromolecule film, LB film, liquid crystal, and deposition film
- Study of exciton dynamics and quantum size effect (for example, semiconductor doped glass and quantum wire)
- Time-resolved fluorescence and phosphorescence spectrum evaluation of organic LED materials
- Study of photonic crystals
- Study, evaluation, and inspection related to fluorescence lifetime measurements in various other fields

Fluorescence phenomena at multiple wavelengths can be measured simultaneously.

Features

● 5 ps temporal resolution

The system uses a streak camera that can achieve a temporal resolution of 15 ps. Through deconvolution processing, a temporal resolution of 5 ps is obtained.

● Simultaneous multi-wavelength measurement

Time-resolved spectrum is acquired in a very short time since fluorescence lifetimes are measured over multiple wavelengths without scanning.

● Two-dimensional photon counting

Ultra-high sensitivity and simultaneous multiple-wavelength measurement capabilities are realized by the combination of photon counting and streak camera techniques. Because fluorescence phenomena at multiple wavelengths can be measured simultaneously, even very-low fluorescence can be detected and measured with high efficiency, a feature not available with previous methods.

● A wide dynamic range better than 100 000 : 1

Measures very-low fluorescence with a dynamic range better than 100 000 : 1*. This allows the an analysis of multi-component fluorescence lifetime with high accuracy.

*Specified value by Streak camera C14831-110+A5309+C13440-20CU

● Measures fluorescence lifetime with good S/N ratio with short integration time

The streak sweep can be operated at up to 20 MHz. Through integration of this high-speed repetitive sweep, measurement with a high S/N ratio can be carried out quickly.

● Covers fluorescence phenomena from picoseconds to milliseconds

Because the sweep time can be varied from 1 ns to 10 ms, a wide range of fluorescence lifetime measurements from picoseconds to milliseconds is possible. For higher temporal resolution, an universal streak camera is optional selection.

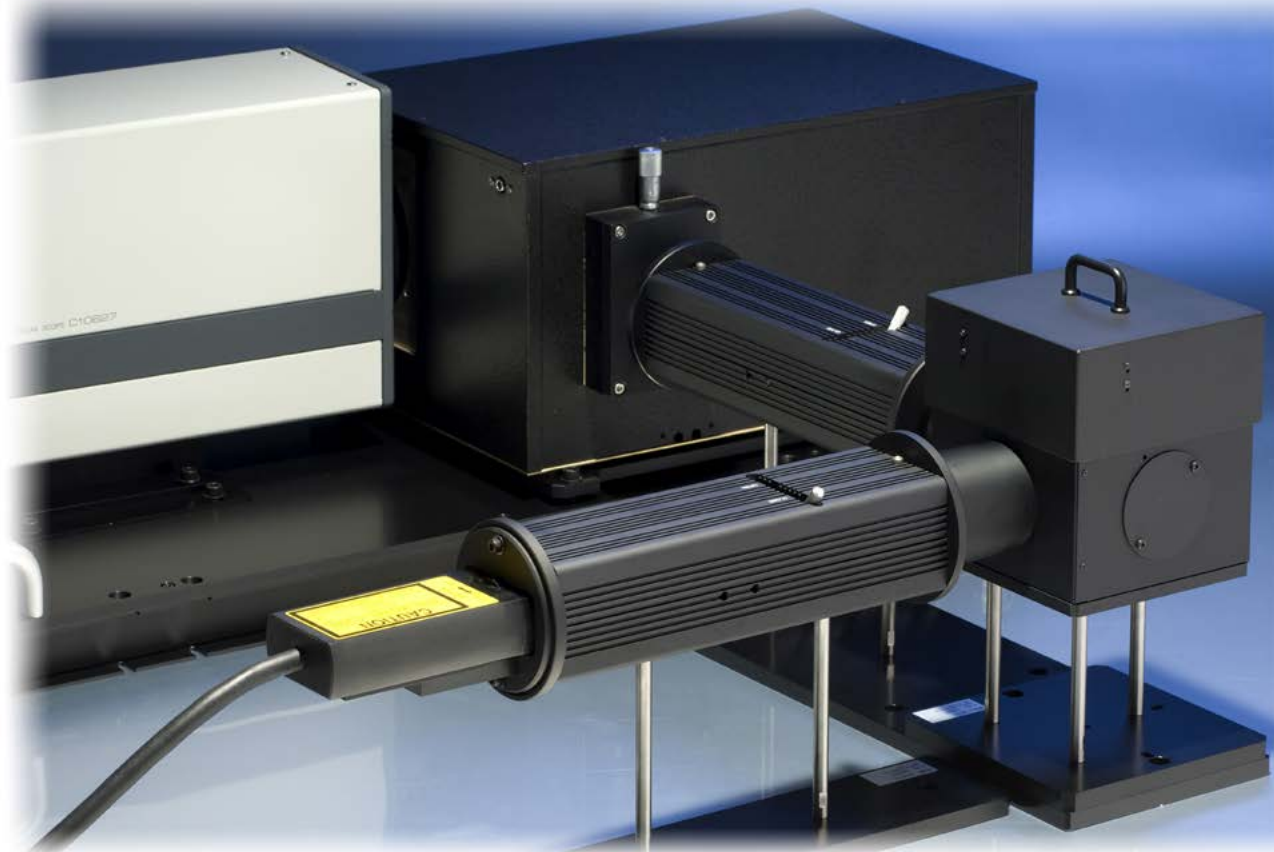
● Covers a wide wavelength range from UV to NIR

Two streak cameras are available, with sensitive regions of 200 nm to 850 nm or 400 nm to 900 nm. NIR streak camera is the optional for the measurement from 1000 nm to 1650 nm.

● High-precision measurement due to a temperature controlled picosecond laser diode

As an excitation light source, picosecond laser diodes are available. Of course, other types of lasers can also be used.

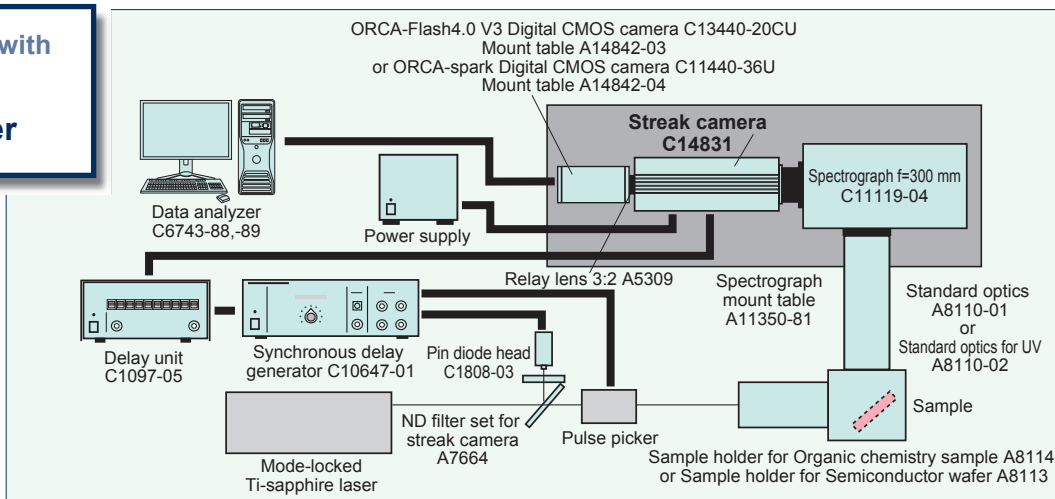
● Standard optical system allows easy optical alignment



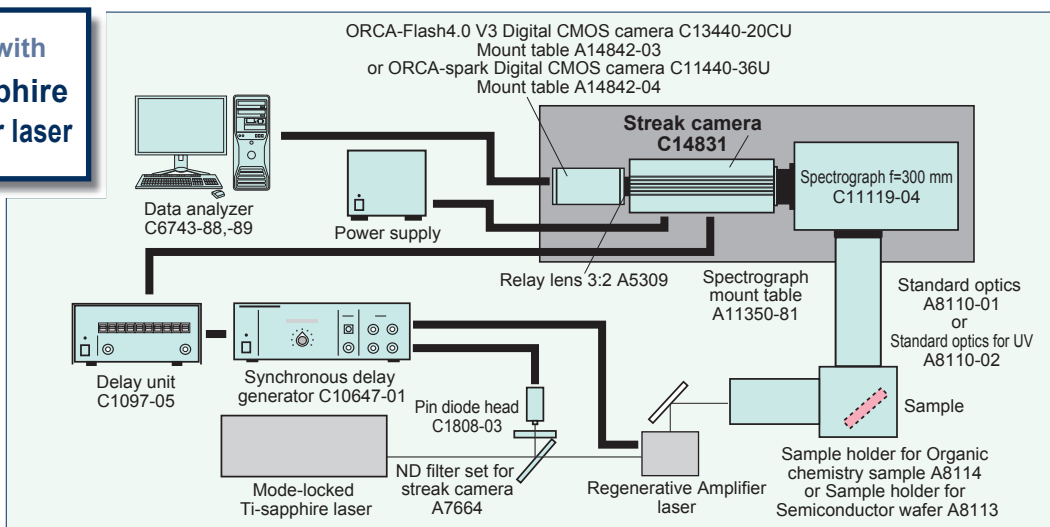
Flexible system configuration supports various types of fluorescence phenomena

System configuration

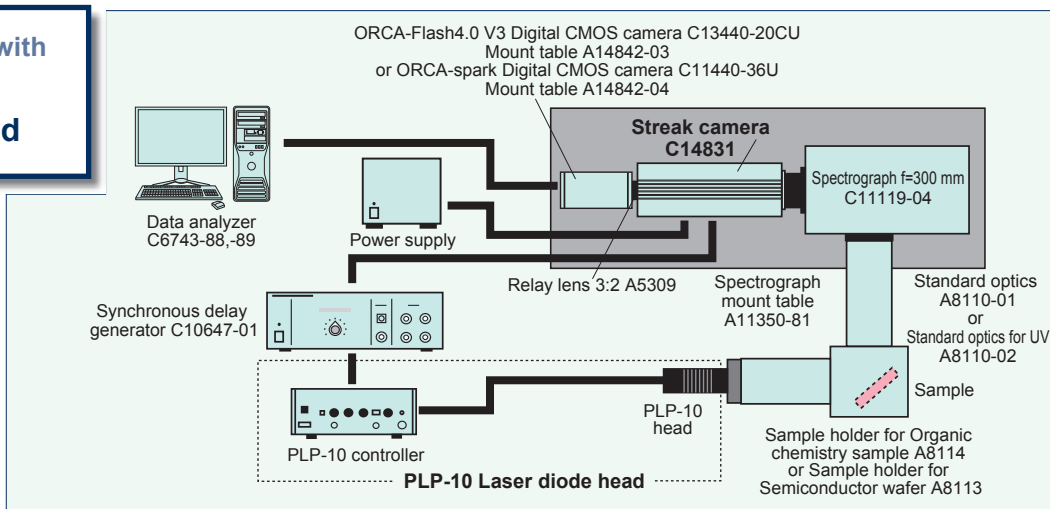
Example when used with Mode-locked Ti-sapphire laser



Example when used with Mode-locked Ti-sapphire + Regenerative Amplifier laser



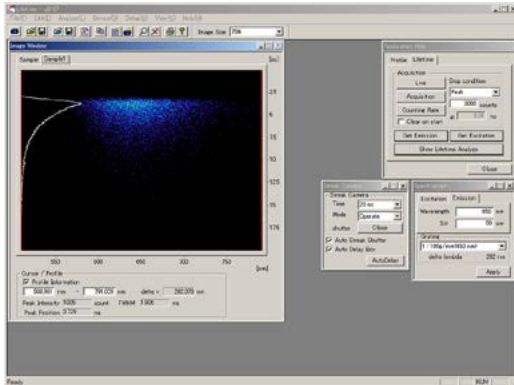
Example when used with PLP-10 Laser diode head



Fluorescence lifetime measurement software with enhanced functions

Fluorescence lifetime measurement software

Measurement screen



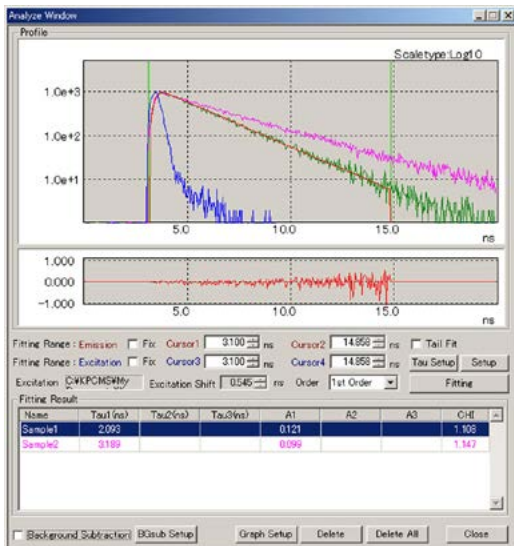
- Controls a streak camera, a spectrograph and a delay generator from a PC.

The streak camera, spectrograph and delay generator control windows are displayed on the PC monitor, which make it easy to change measurement parameters such as time scales and monitor wavelength selection. The "Auto delay" function eliminates the need to adjust the timing for each time scale even when the scale was changed.

- Real-time display of time profiles and spectrum

Time profiles or spectrum are displayed on the monitor screen in real-time. This is a useful function for selecting the time scale during measurement or determining the analysis data range.

Lifetime analysis



- Multi-component analysis

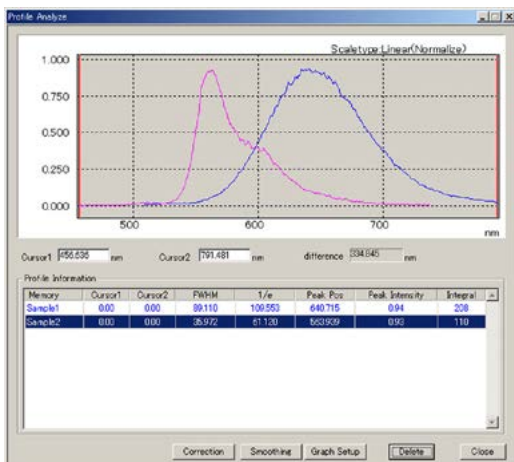
- Multiple data analysis on the same screen

Calculated fluorescence lifetime values are also displayed on the same screen for easy comparison analysis.

- Highly accurate analysis by deconvolution

Deconvolution processing enables fluorescence lifetime analysis with high accuracy. When analyzing longer lifetime components such as phosphorescence, the "Tail Fit" function can be used instead of deconvolution processing.

Profile analysis



- Time-resolved spectrum display

Allows time-resolved spectrum display the greatest feature offered by streak camera systems.

- Spectrum and fluorescence decay curve display

Displays the full width at half maximum (FWHM), peak position and peak intensity for each profile

- Multiple data loading and comparison on the same screen.

Normalized processing makes multiple data comparison easy.

The streak camera enables time-resolved photon counting at multiple wavelengths in a single measurement.

Operating principle, functions and performance

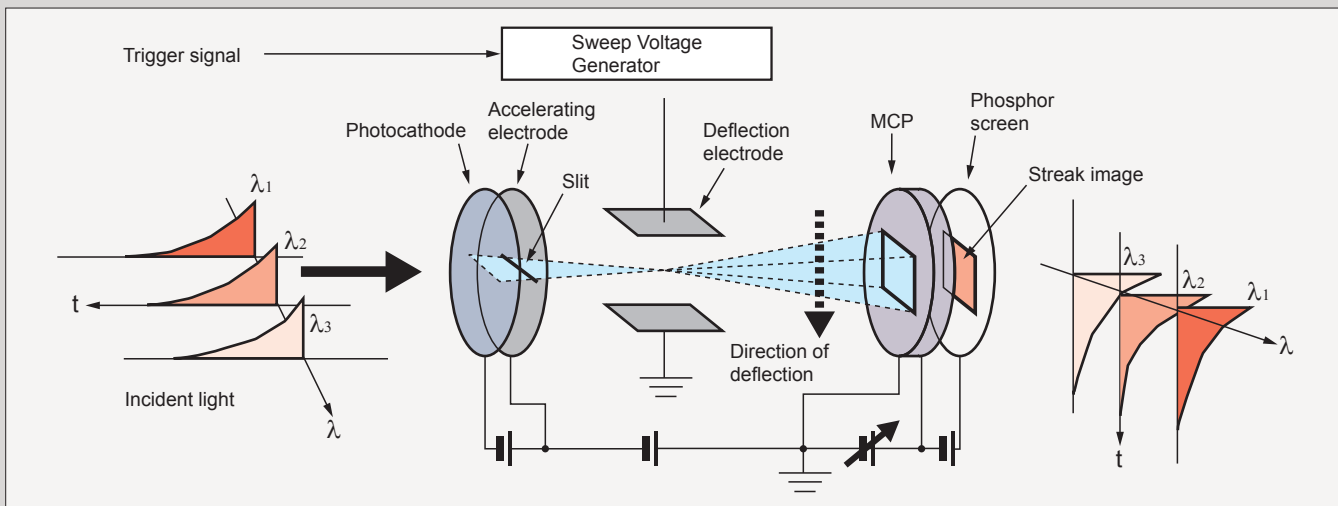


Figure 1: Operating principle of the streak camera

1. Principle of streak method

This section explains the principle and features of fluorescence lifetime measurements using the streak camera. (In the following description, this method is simply called the "streak method").

The heart of the streak camera is an electron tube called the "streak tube". Figure 1 shows the operating principle of a streak tube. When fluorescence pulses enter the photocathode, they are converted into photoelectrons in proportion to the number of incident photons. Being accelerated by the accelerating electrode, these photoelectrons pass through a pair of deflection plates. At the instant they pass through the deflection plates, a high-speed sweep voltage is applied to the deflection plates so that the photoelectrons' trajectories are swept from top to bottom.

The swept photoelectrons are then multiplied in the microchannel plate (MCP) by a factor of 10^4 , and reconverted into an optical image by the phosphor screen. The optical image produced on the phosphor screen is called the "streak image". In this way, time is converted into the spatial axis (vertical axis): thus, the time in which the photons reached the photocathode and the intensity can be determined by the position and luminance of the streak image. In addition, because the position information in the horizontal direction on the photocathode is contained in the horizontal direction of the streak image, if a spectrograph is used to focus a spectrum onto the photocathode, a streak image can be obtained in which the vertical axis serves as the time axis and the horizontal axis as the wavelength axis, and in which the luminance is proportional to the intensity on the phosphor screen.

The streak images thus obtained are read out by a CCD camera coupled to the streak tube. To perform data measurement with a high S/N ratio, the read-out streak images are integrated in a memory of computer. In this case, there are two methods of integration: 1) the analog integration method, in which the output signal from the CCD camera is directly integrated to create an image, and 2) the photon counting method, in which the signal is separated from noise by setting a threshold level, and only the signal is integrated. (See Section 2.) By using these two methods properly, a wide variety of fluorescence intensity can be measured, ranging from extremely weak fluorescence, for example, in cases where only one photon is detected as a result of hundreds of excitations, to bright fluorescence which is visible to the human eye.

The above figure shows the principle how intensity profiles are extracted from a time-resolved spectrum image. After the full spectrum has been recorded, the fluorescence decay curves can be extracted at arbitrary wavelength bands by just placing vertical sampling windows at the desired positions. Alternatively, by using horizontal windows, it would also be possible to extract spectral profiles at various time positions and "gate" lengths.

2. Principle of photon counting method using streak camera

The photoelectrons emitted from the photocathode of the streak tube are multiplied by the MCP with a high gain. One photoelectron can be observed as one light spot produced on the phosphor screen.

This photoelectron image is read out by a CCD camera, and then undergoes digitization. Because the noise level of the CCD is exceptionally low, the photoelectron image can be clearly separated from the noise by setting a threshold level. Figure 2 shows this threshold level setting.

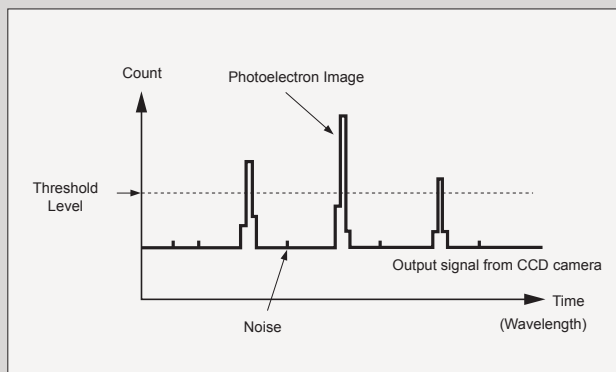


Figure 2: Separating the photoelectron image from noise

With the threshold set at an appropriate level, detecting the position of the photoelectron image and integrating it in the memory allow data measurement with a high S/N ratio, wide dynamic range. Moreover, this photon counting method is carried out over the entire surface of the 2 dimensional streak image, enabling photon counting measurement to be made at simultaneous multiple wavelengths. Also, even if multiple photo-electrons are produced by one excitation, they can be counted. Consequently, in the case of time-resolved spectrophotometry, the streak method offers high-sensitivity measurement which is two orders of magnitude higher than the conventional time-correlated single photon counting method requiring a wavelength scan in a spectrograph for wavelength isolation.

3. Functions of the streak camera

The streak method offers the following features:

- High temporal resolution
- Wide dynamic range and high S/N ratio due to photon counting integration
- Simultaneous multiple-wavelength measurement for fluorescence lifetime analysis and time-resolved spectrophotometry

[High temporal resolution]

Conventional time-correlated single photon counting methods using a photomultiplier tube have proven inadequate in fluorescence lifetime measurement and rise-time analysis in the order of subnanoseconds, because temporal resolution is limited to about 1 ns and the signal waveform may be distorted by the TTS (photoelectron transit time spread) of the photomultiplier. The streak camera C14831 used with the streak method has a superior temporal resolution of better than 15 ps, and furthermore, it is free of waveform distortion. (Figure 3 shows the device function of the streak camera C14831.) As seen from the figure, the device function is negligibly small. Therefore, the streak method is capable of fluorescence lifetime measurement and rise-time analysis from several picoseconds to nanoseconds with high accuracy, both of which have been difficult with conventional methods. The streak sweep time is switchable between 1 ns and 10 ns full scale, allowing a wide range of fluorescence analysis from picoseconds to milliseconds.

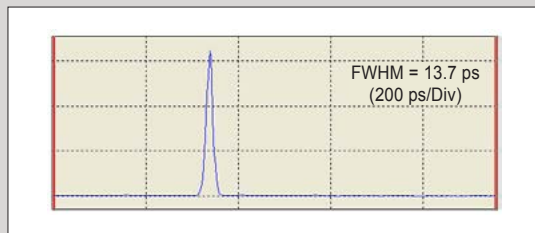


Figure 3: Device function of the streak camera C14831

[Wide dynamic range and S/N ratio due to photon counting]

In addition to high temporal resolution, the streak camera features high sensitivity and a wide dynamic range.

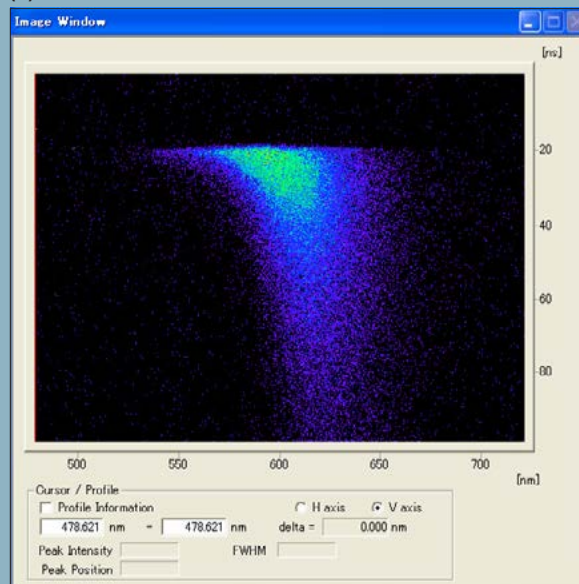
In photon counting integration, a major factor that determines the detection limit of the light level is the dark current (noise) of the photocathode. The photocathode dark current of the C14831 is smaller than that of the photomultiplier tube used in the conventional time-correlated single photon counting method by 3 orders of magnitude: thus, the streak method offers a high S/N ratio in measuring even very low fluorescence. Also, low dark current assures a low noise level, thereby easily achieving a wide dynamic range better than 100 000 : 1. This enables multi-component fluorescence lifetime analysis to be made with high accuracy. On the other hand, in cases where fluorescence intensity is so high that it may saturate in the photon counting method, the C14831 can be switched from the photon counting integration method mode to the analog integration mode, making possible highly efficient measurement without reducing the signal light level. Consequently, the C14831 is the most ideal device currently available in optical measurements.

[Simultaneous multiple-wavelength measurement]

As explained in the section on "Principle of streak method", the combination of the C14831 with a spectrograph enables simultaneous multiple wavelength measurement to be made. In conventional time-correlated single photon counting, because simultaneous multiple-wavelength measurement is not possible, the wavelength range to be observed must be scanned for time-resolved spectrophotometry and multiple-wavelength fluorescence lifetime analysis. These measurements sometimes require several hours. As the streak camera C14831 is capable of simultaneous multiple-wavelength measurement without doing the wavelength scan in the spectrograph, it greatly reduces the time needed to obtain a time-resolved spectrum. In particular, this will prove dramatically effective when fluorescence is very low.

Measurement examples

(a)



(b)

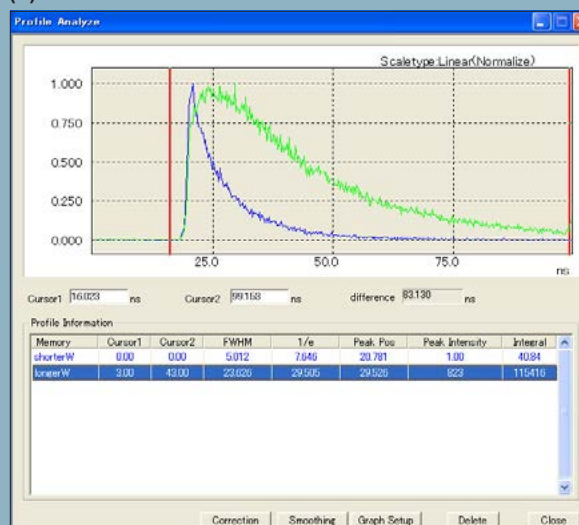


Figure 4: Colloidal quantum dots (CdSe/ZnS Core/Shell structure)
 (a) Streak image of time-resolved luminescence spectra.
 (b) Decay curves at different wavelength ranges.

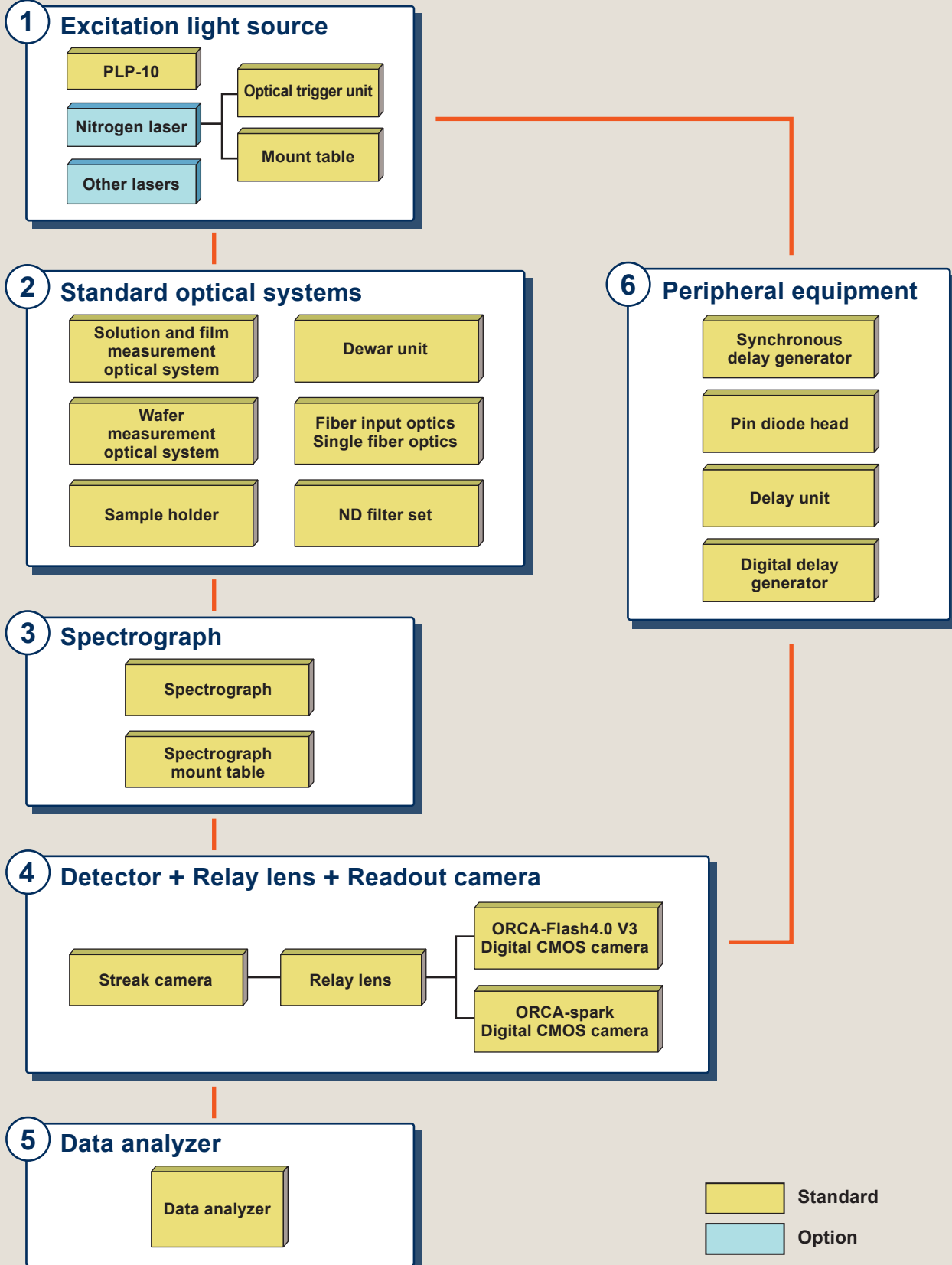
- The lifetime of QDs at different longer wavelength (600 nm to 670 nm) is longer than that of shorter wavelength (540 nm to 600 nm). The lifetime distribution does not correspond to the photoluminescence peak distribution.

This novel material is expected to be applied for fluorescent material, LED material, single photon source, and bio-labeling. These results open the possibility to experimentally study the behavior of exciton dynamics of colloidal QDs including energy transfer between QDs.

*Data produced by Professor Yong-Hoon Cho
 Nano-Bio-Photonics Laboratory, Dept. of Physics,
 Korea Advanced Institute of Science and Technology (KAIST), Korea

The optimum system can be tailored to your samples by selecting the excitation light source, optics, spectrograph, etc.

Configuration and specifications



1 Excitation light source

To excite a specimen, various pulsed light sources are provided.

● PLP-10 Laser diode head M10306

The PLP-10 is a picosecond light pulser using a temperature controlled laser diode. It is virtually maintenance-free and generates stable picosecond pulsed light over a long period of time.



Type	Laser diode (temperature-controlled)
Laser wavelength*	375 nm, 405 nm, 445 nm, 465 nm, 483 nm, 510 nm, 655 nm, 785 nm, 850 nm
Output pulse width	50 ps to 130 ps
Repetition rate	max. 100 MHz
Peak power (typ.)	50 mW to 60 mW (It depends on each laser head.)

* Select one wavelength from among these wavelengths.

● Other excitation light sources

Besides the PLP-10 above, various types of excitation light sources can be used according to the specimens to be measured. These include a nitrogen-laser-pumped dye laser, semiconductor-laser-pumped Q-switched YAG laser, and mode-locked laser.

● Optical trigger unit C12518-01

C12518-01 generates trigger signal synchronized with pulsed laser being input, and output pulsed laser light through an optical fiber which transmits UV light. For use in combination with C12518-01, streak camera C14831 and laser such as nitrogen laser which generate relatively high trigger jitter.

● Mount table for nitrogen laser A12517-01

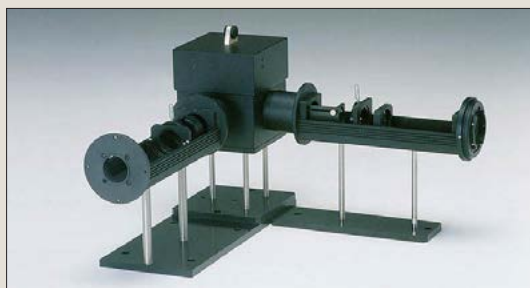
The A12517-01 is a mount table for coupling an optical trigger unit and a nitrogen laser.

2 Standard optical systems

Various optical systems are available for solution and solid state specimens. Select from the list below the optical system that best matches the specimen of interest. Fiber optics and excitation light guide adapters for microscopes are also available. Please consult Hamamatsu should the specimen of interest require temperature control.

Type number	Product name
A8110-01	Standard optics
A8110-02	Standard optics for UV
A8111	Base plate for standard optics
A8112-02	Sample holder for Optistat DN cryostat
A8113	Sample holder for Semiconductor wafer
A8114	Sample holder for Organic chemistry sample
A8790	Dewar unit for A8110
A7664	ND filter set for streak camera
A5760	Fiber input optics for nitrogen laser
A5760-02	Single fiber optics with 3 m fiber

Aside the above optical systems, we also design custom optical systems ideal for the specimens of interest. Your own optical systems can also be used.



▲ Standard optics A8110 and Sample holder for Organic chemistry sample A8114



▲ Sample holder for Semiconductor wafer A8113



▲ Dewar unit for A8110 A8790

3 Spectrograph

● Spectrograph f=300 mm C11119-04

The C11119-04 is a Czerny-Turner type spectrograph with a focal length of 300 mm and an aperture of F/4. Due to the aberration-corrected optics, it is highly efficient in focusing light to the streak camera detector, enabling high-sensitivity measurements. More than twenty optional gratings are available for the C11119-04, and up to three gratings can be installed at one time. Grating and wavelength selection is controlled by the integrated streak camera software, in addition to the entrance slit width, for fine control of incident light.

Optics system	Czerny-Turner type (with aberration-corrected toroidal mirror)
Focal length	Collimating 300 mm
Aperture ratio	F/4
Incident slit	Variable between 10 μm and 3000 μm
Grating mount	Grating mount accommodates up to 3 gratings. (It is possible to add turret as an optional extra.)



● Gratings (typical examples)

Type Number	No. of Grooves	Blaze Wavelength	Wavelength Range	Measurement Wavelength Range *	Resolution
A13302-25	40 gr/mm	500 nm	335 nm to 750 nm	Approx. 316 nm	Approx. 5.1 nm
A13302-26	50 gr/mm	600 nm	400 nm to 1200 nm	Approx. 253 nm	Approx. 4.2 nm
A13302-27	100 gr/mm	450 nm	300 nm to 700 nm	Approx. 126 nm	Approx. 2.1 nm
A13302-28	150 gr/mm	300 nm	200 nm to 500 nm	Approx. 84 nm	Approx. 1.4 nm
A13302-29	150 gr/mm	500 nm	335 nm to 750 nm	Approx. 84 nm	Approx. 1.4 nm
A13302-30	150 gr/mm	800 nm	535 nm to 1200 nm	Approx. 84 nm	Approx. 1.4 nm
A13302-32	300 gr/mm	300 nm	200 nm to 500 nm	Approx. 41 nm	Approx. 0.7 nm
A13302-33	300 gr/mm	500 nm	335 nm to 750 nm	Approx. 41 nm	Approx. 0.7 nm
A13302-34	300 gr/mm	750 nm	500 nm to 1100 nm	Approx. 41 nm	Approx. 0.7 nm
A13302-38	600 gr/mm	500 nm	335 nm to 750 nm	Approx. 20 nm	Approx. 0.34 nm
A13302-44	1200 gr/mm	500 nm	335 nm to 750 nm	Approx. 9 nm	Approx. 0.16 nm

* This is the wavelength range within which simultaneous measurement is possible when used in combination with the streak camera C14831.

● Spectrograph mount table A11350-81

The A11350-81 is a mount table for coupling the streak camera C14831 and the spectrograph f=300 mm C11119-04.

4 Detector, Relay lens, Readout camera

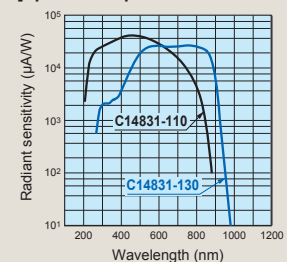
The heart of the C11200 system is an ultrafast optical detector - the streak camera C14831. It can capture very weak luminescence phenomena, from picoseconds to milliseconds, achieving very high signal-to-noise ratio within short measuring times due its high repetition rates of up to 20 MHz. The spatial axis of the C14831 allows multichannel spectral measurement, making it the ideal detector for time-resolved spectroscopy. The integrated readout camera has a high frame rate of up to 150 Hz, so that high photon count rates can be exploited in case of stronger emissions. The system is completely remote-controlled from the data analyzer. For any demanding applications where the temporal resolution of the C14831 is not sufficient, you can choose among several alternative detectors such as the C10910 with a resolution of better than 1 ps, the C11293 with a high sensitivity in a near-infrared region.

● Streak camera C14831 (standard)

Sensitivity wavelength range	C14831-110	200 nm to 850 nm
	C14831-130	400 nm to 900 nm
Temporal resolution	20 ps FMHM max. (fastest range)	
Maximum repetition frequency	20 MHz (fastest range)	
Sweep time (full screen)	1 ns, 2 ns, 5 ns, 10 ns, 20 ns, 50 ns, 100 ns, 200 ns, 500 ns, 1 μs, 2 μs, 5 μs, 10 μs, 20 μs, 50 μs, 100 μs, 200 μs, 500 μs, 1 ms, 2 ms, 5 ms, 10 ms	



[Spectral response of streak tube]



● Relay lens 3:2 A5309

The A5309 is lens optics for coupling the streak camera C14831 and a readout camera.

Magnification	3 : 2
Effective F value	1.95

● ORCA-Flash4.0 V3 Digital CMOS camera C13440-20CU

Standard readout camera for streak camera applications with extremely low readout noise and high frame rate.

Effective number of pixels	2048(H) × 2048(V)
Number of pixels on working area	976(H) × 728(V)
Cell size	6.5 μm(H) × 6.5 μm(V)
Effective area	13.312 mm(H) × 13.312 mm(V)
Frame rate	200 frames/s (Sub-array read out of the effective area, CameraLink)
Readout noise (rms) typ.	6.6 electrons
Working area on phosphor screen	9.516 mm(H) × 7.098 mm(V)
Exposure time	1 ms to 10 s (Standard scan internal trigger mode with full resolution)
Digital output	16 bit

● ORCA-spark Digital CMOS camera C11440-36U

Low cost model of readout camera. Balanced performance at readout noise and frame rate.

Effective number of pixels	1920(H) × 1200(V)
Number of pixels on working area	1078(H) × 808(V)
Cell size	5.86 μm(H) × 5.86 μm(V)
Effective area	11.25 mm(H) × 7.03 mm(V)
Frame rate	94 frames/s (Sub-array read out of the effective area, USB 3.0)
Readout noise (rms) typ.	6.6 electrons
Working area on phosphor screen	9.476 mm(H) × 7.102 mm(V)
Exposure time	26.17 μs to 10 s (Internal trigger mode)
Digital output	12 bit



▲ ORCA-Flash4.0 V3 Digital CMOS camera C13440-20CU



▲ ORCA-spark Digital CMOS camera C11440-36U

● Mount table A14842

The A14842 is a mount table for coupling a readout camera for streak camera.

A14842-03	For C14831 + ORCA-Flash4.0 V3
A14842-04	For C14831 + ORCA-spark

5 Data analyzer C6743-88, -89

The dedicated software controls the streak camera, spectrograph and peripheral units to perform fluorescence lifetime analysis. The software runs under Windows. Fitting analysis enables 5 component analysis.

Control functions	<ul style="list-style-type: none"> ● Streak camera C14831 Time axis setting Gain setting Shutter control (only for C14831 accessory) ● Spectrograph f=300 mm C11119-04 Center wavelength setting Grating selection
Data acquisition functions	Photon-counting integration (Peak Detection, Slice) Analog integration
Correction and calibration functions	Time axis calibration (Calibrated prior to shipment) Wavelength calibration (Requires optional light source for calibration) Dark current correction Shading correction (Requires optional light source for calibration)
Data analysis functions	5 component exponential function analysis by fitting Profile analysis (wavelength axis, time axis)
Interface	CameraLink (C6743-88) USB 3.0 (C6743-89)

6 Peripheral equipment

● Synchronous delay generator C10647-01

When using a Ti-Sapphire laser in conjunction with a pulse picker, this unit generates low-jitter trigger signals synchronized with the laser repetition rate. Also, it is generated for to adjust performance timing of PLP-10 and streak camera.



● Trigger mode

INTERNAL mode, EXTERNAL mode, DUMP mode

● Input signal, Output signal

Mode-lock IN	Input signal frequency	10 MHz to 200 MHz
	Input signal level	0 dBm to 15 dBm
	Impedance	50 Ω
TRIG.IN	Input signal frequency	0 Hz to 16 MHz
	Input signal level	+0.25 V to +3.3 V
	Impedance	50 Ω/High Z (10 kΩ)
OUTPUT A	Output signal level	2 V
	Impedance	50 Ω
OUTPUT B, C, D	Output signal level	2.5 V
	Impedance	50 Ω
Interface	RS232C	

● Pin diode head C1808-03

The C1808-03 generates a low-jitter trigger signal when coupled with various lasers including passive mode-locked lasers. A specially designed circuit produces a highly stable trigger signal compatible with the streak camera C14831.

Minimum optical Input level	1.0 mW (f=80 MHz, λ=800 nm, FWHM < 1ps)
Maximum output signal level	1.7 V p-p (50 Ω)
Optical Input signal frequency	76 MHz to 100 MHz

● Delay unit C1097-05

The C1097-05 is a passive delay unit, with zero jitter, used for fine tuning the trigger delay times to match the selected streak time.



Variable delay range	0 ns to 31.96 ns
Delay setting range	30 ps, 60 ps, 120 ps, 250 ps, 500 ps, 1 ns, 2 ns, 4 ns, 8 ns, 16 ns,
Interface	USB 2.0

● Digital delay generator DG645 C13430-02

This is a general-purpose delay generator that matches the streak camera timing with the pulsed laser timing, mainly for slower streak times.

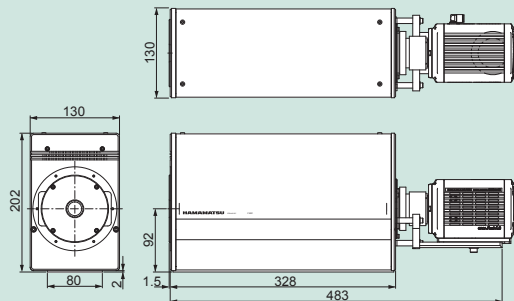


Number of output channels	4 ch (AB, CD, EF, GH output terminal)
Output level	0.5 V to 5.0 V 50 Ω
Variable delay range	0 ps to 2000 s
Delay resolution	5 ps
Internal delay time	85 ns
Repetition rate	Single to 10 MHz
Jitter	25 ps rms
Interface	GPIO, RS232C, Ethernet

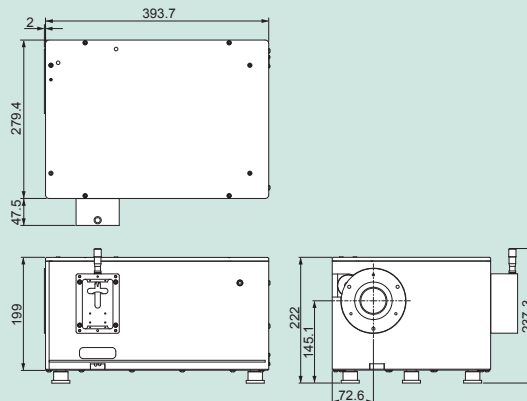
Dimensional outlines

(Unit: mm)

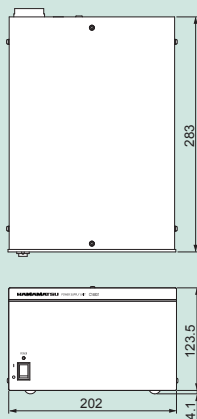
- **Streak camera C14831** (Approx. 7.5 kg)
- +Relay lens 3:2 A5309 (Approx. 0.2 kg)
- +ORCA-Flash4.0 V3 Digital CMOS camera C13440-20CU (Approx. 2.2 kg)
- +Mount table A14842-03 (Approx. 0.3 kg)



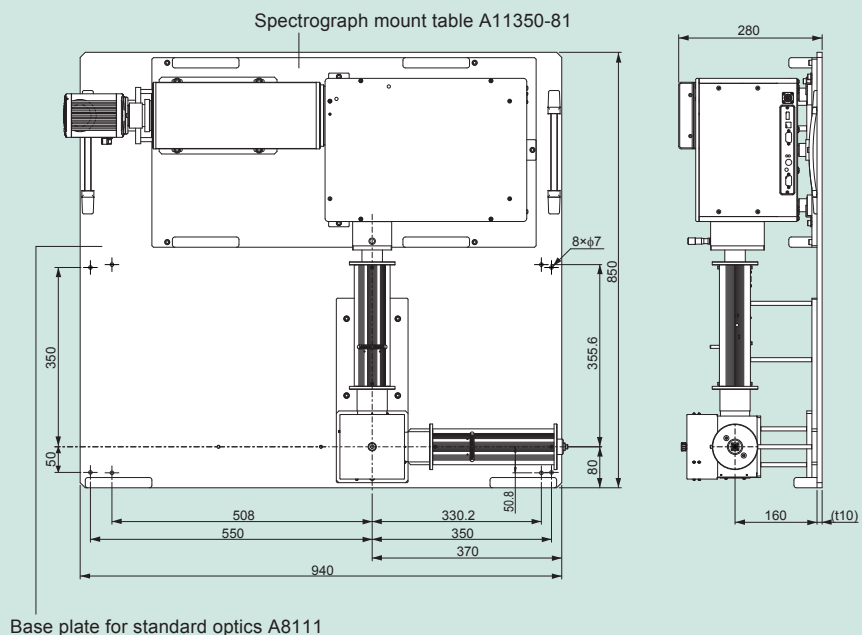
- **Spectrograph f=300 mm C11119-04** (Approx. 19.5 kg)



- **Power supply unit for C14831** (Approx. 3 kg)



- **Base plate for standard optics A8111** (Approx. 24 kg)
- **Spectrograph mount table A11350-81** (Approx. 14 kg)



- Product and software package names noted in this documentation are trademarks or registered trademarks of their respective manufacturers.
- Subject to local technical requirements and regulations, availability of products included in this promotional material may vary. Please consult your local sales representative.
- Information furnished by HAMAMATSU is believed to be reliable. However, no responsibility is assumed for possible inaccuracies or omissions.

Specifications and external appearance are subject to change without notice.

© 2018 Hamamatsu Photonics K.K.

HAMAMATSU PHOTONICS K.K. www.hamamatsu.com

HAMAMATSU PHOTONICS K.K., Systems Division

812 Joko-cho, Higashi-ku, Hamamatsu City, 431-3196, Japan, Telephone: (81)53-431-0124, Fax: (81)53-433-8031, E-mail: export@sys.hpk.co.jp

U.S.A.: Hamamatsu Corporation: 360 Foothill Road, Bridgewater, NJ 08807, U.S.A., Telephone: (1)908-231-0960, Fax: (1)908-231-1218 E-mail: usa@hamamatsu.com

Germany: Hamamatsu Photonics Deutschland GmbH: Arzbergerstr. 10, D-82211 Herrsching am Ammersee, Germany, Telephone: (49)8152-375-0, Fax: (49)8152-265-8 E-mail: info@hamamatsu.de

France: Hamamatsu Photonics France S.A.R.L.: 19, Rue du Saule Trapu, Parc du Moulin de Massy, 91882 Massy Cedex, France, Telephone: (33)1 69 53 71 00, Fax: (33)1 69 53 71 10 E-mail: infos@hamamatsu.fr

United Kingdom: Hamamatsu Photonics UK Limited: 2 Howard Court, 10 Tewin Road, Welwyn Garden City, Hertfordshire AL7 1BW, UK, Telephone: (44)1707-294888, Fax: (44)1707-325777 E-mail: info@hamamatsu.co.uk

North Europe: Hamamatsu Photonics Norden AB: Torshamngatan 35 16440 Kista, Sweden, Telephone: (46)8-509 031 00, Fax: (46)8-509 031 01 E-mail: info@hamamatsu.se

Italy: Hamamatsu Photonics Italia S.r.l.: Strada della Moia, 1 int. 6, 20020 Arese (Milano), Italy, Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41 E-mail: info@hamamatsu.it

China: Hamamatsu Photonics (China) Co., Ltd.: 1201 Tower B, Jiaming Center, 27 Dongsanhuan Beilu, Chaoyang District, 100020 Beijing, China, Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866 E-mail: hpc@hamamatsu.com.cn

Taiwan: Hamamatsu Photonics Taiwan Co., Ltd.: 8F-3, No.158, Section2, Gongdao 5th Road, East District, Hsinchu, 300, Taiwan R.O.C. Telephone: (886)03-659-0080, Fax: (886)03-659-0081 E-mail: info@hamamatsu.com.tw

Cat. No. SHSS0008E07
JUN/2018 HPK
Created in Japan