FluoTime 300 "Easy Tau"

PicoQuant

Automated, High Performance Fluorescence Lifetime Spectrometer

- Fully automated system
- Easy-to-use application wizards
- Modular and flexible design
- Picosecond time resolution
- Ultimate sensitivity
- High dynamic range
- Steady-state option

Applications

- Time-resolved fluorescence spectroscopy
- Fluorescence anisotropy decay analysis
- Ultra sensitive analysis
- Photochemistry
- Solar cell research
- Singlet oxygen
- Material research

Standard Components

The FluoTime 300 “Easy Tau” is a fully automated, high performance fluorescence lifetime spectrometer with steady-state option. It contains the complete optics and electronics for recording fluorescence decays by means of Time-Correlated Single Photon Counting (TCSPC) or Multichannel Scaling (MCS). The system is designed to be used with picosecond pulsed diode lasers or LEDs. Multiple detector options enable a large range of system configurations. With the FluoTime 300 decay times down to a few picoseconds can be resolved.

Sample chamber
The sample chamber contains a versatile sample holder (standard: cuvette, optional: front-face). Temperature control of the cuvette holder is possible by attaching an external thermostat (tubing for the circulating fluid is pre-installed) or with an optional peltier-cooled single- or multi-cuvette sample holder. A cryostat can be integrated for measurements at low temperature.

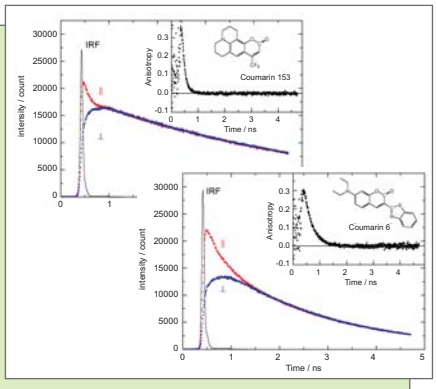
Excitation sources
The FluoTime 300 is designed to be used with picosecond pulsed lasers or LEDs. These flexible excitation sources are available in a very broad wavelength range from 255 to 1550 nm. They can be varied in output power and operated at any repetition rate from single shot to 80 MHz (depending on wavelength) and thus allow to match the excitation conditions ideally to the sample requirements. A specialized driver unit of the PDL Series, the PDL 820, is used to control the individual excitation source.

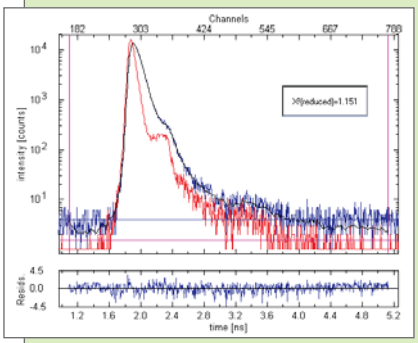
TCSPC data acquisition
The data acquisition module PicoHarp 300 contains the complete timing electronics for Time-Correlated Single Photon Counting (TCSPC). The system works in forward start-stop mode, still operating at laser repetition rates up to 84 MHz. The temporal resolution can be selected to be as short as 4 picoseconds and the maximum full time span extends up to 33 µs. An separate data acquisition board for decays up to several hundred milliseconds (phosphorescence) is also available.

Detector
The PMA detector unit is recommended for the majority of applications. The unit has a built-in high voltage power supply, signal pre-amplifier for optimal timing performance and a nickel coated aluminum housing for maximum shielding. With this detector unit, an Instrument Response Function (IRF) shorter than 200 ps can be achieved. An alternative detector, based on the Hamamatsu R3809 series microchannel-plate photomultiplier tube (MCP-PMT), combined with fast laser sources, can achieve an IRF of less than 50 ps. Cooling is availble for both detector types to reduce the number of dark counts.

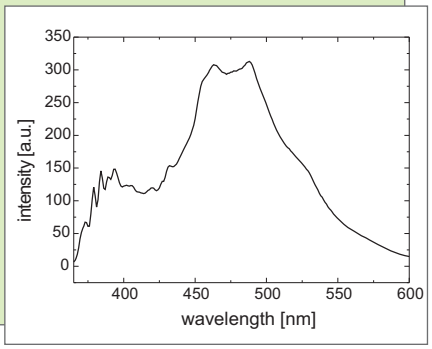
Measurement Examples

The example on the right shows a time-resolved anisotropy measurement of Coumarin 153 (C153) and Coumarin 6 (C6) in dimethyl sulfoxide (DMSO) at a temperature of 290 K. The sample was excited with a LDH-P-C-405 diode laser and the emission at 500 nm was monitored with an MCP-PMT. The FluoTime 300 was equipped with Glan-Taylor prism polarizers. The figures show the recorded polarized decays, the IRF of the measurement and the calculated fluorescence anisotropy decay together with a structure of the com- pounds. Fitting the anisotropy decay to a single exponential model without reconvolution yields a 110 ps and 330 ps rotational correlation time for C153 and C6, respectively. The results reflect the prolongated molecular shape of C6, in comparison to C153.





Time-resolved fluorescence measurement of DASPI (10^{-6} molar in Ethanol) using a FluoTime 300 equipped with a MCP-PMT and the PicoHarp 300. The sample was excited with a LDH-P-C-405 picosecond diode laser with a 70 ps FWHM pulse width at 20 MHz repetition rate. Fluorescence response at 590 nm was detected through a single monochromator. The plot shows the measured Instrument Response Function (red), the sample decay (blue) and the fitted decay (black). The fitted fluorescence lifetime is 65 ±5 ps.

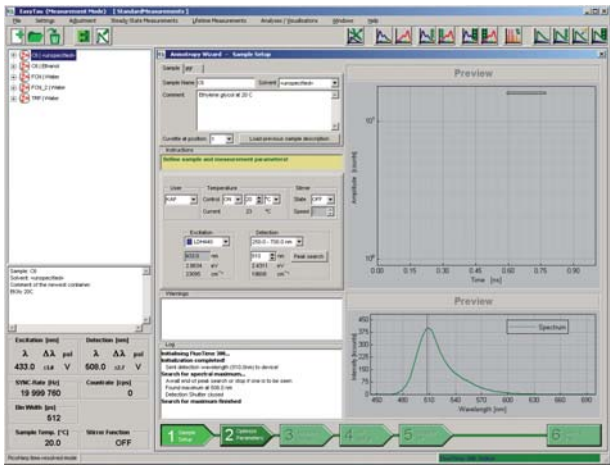


Emission spectrum (uncorrected) of a pyrene solution (concentration approx. 1 mMol/l) in cyclohexane obtained with a FluoTime 300 equipped with a PMT. The sample was excited with a LDH-P-C-375B and the fluorescence emission was collected between 360 nm and 600 nm in 1 nm steps. The measurement time per data point was 0.5 seconds, leading to a total measurement time of 2 minutes. The structured band in the blue/UV part of the spectrum can be related to monomer fluorescence, whereas the broad band structure in the visible part is due to excimer fluorescence.

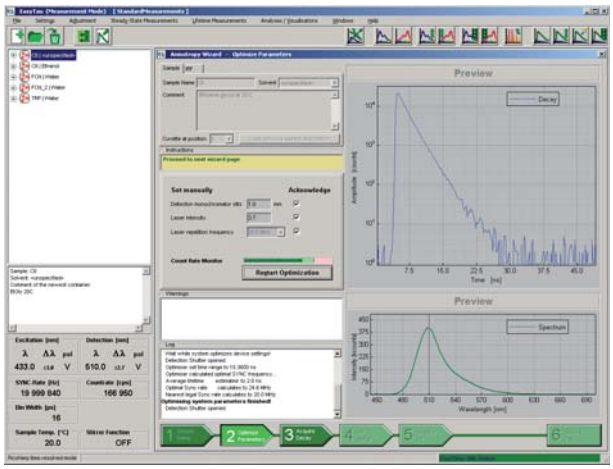
System Software with Application Wizards

The FluoTime 300 “Easy Tau” features an intuitive and easy-to-use system software. All measurement data files and all related analysis results are stored in a clearly arranged workspace, which resembles the familiar tree structure of a hard drive directory. Data dependencies are thus visible at first glance.
Specifically designed application wizards guide the user through the necessary steps for performing typical measurement tasks such as fluorescence lifetime measurements, anisotropy measurements, collection of emission spectra or Time-Resolved Emission Spectra (TRES). An additional expert mode for individual full instrument control will also be available for more sophisticated application tasks.

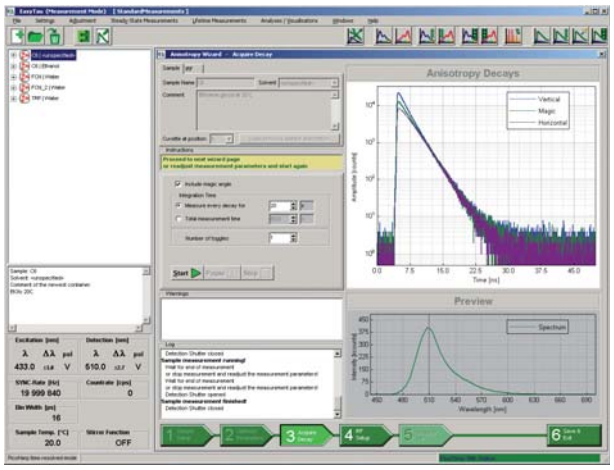
Example of a wizard: Acquiring fluorescence lifetime decays



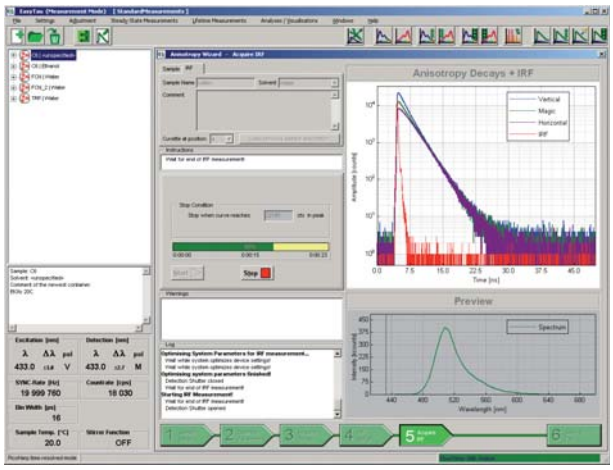
The user is asked to enter information about the sample and to define the relevant measurement parameters such as solvent, excitation and detection wavelength.



The wizard then automatically optimizes the system for best performance by varying signal intensity, temporal resolution, laser repetition rate, etc.

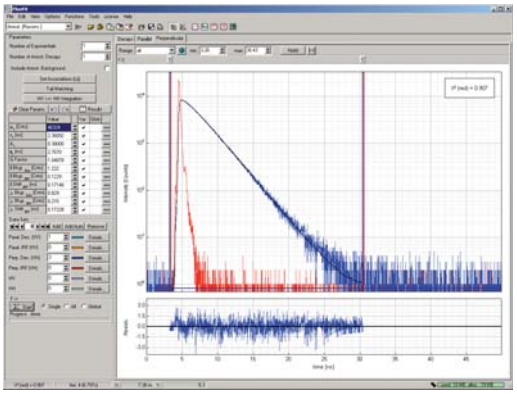


After the successful optimization, the fluorescence decay is measured according to the suggested or user specified settings.



A second optimization run is performed in order to adjust the system for recording an Instrument Response Function (IRF). After the measurement, decay and IRF are stored in the hierarchical workspace for further analysis.

Data analysis
The direct transfer of all measurement data to the established FluoFit software is part of the software functionality. The FluoFit software features global decay analysis with an easy-to-use graphical user interface and presentation-ready numerical and graphical output.



It implements an iterative reconvolution fitting routine with nonlinear error minimization. Various exponential decay models (up to fourth order) or rate constant distribution models can be fitted to the observed decay in order to determine the fluorescence lifetime(s) or to study fluorescence anisotropy.

Specifications

System
Optical configuration . . . . . L-Geometry or T-Geometry available
Mode of operation. . . . . Time-Correlated Single Photon Counting (TCSPC), Multichannel Scaling (MCS)[1)]

Monochromator*
Type . . . . . Czerny-Turner Design
Focal length and aperture . . . . . 150 mm, f/4.2
Stray light rejection . . . . . 10^{-5}
Grating*. . . . . 1200 g/mm, blazed at 500 nm
Step size (min) . . . . . 0.01 nm
Slit width adjustable between . . . . . 10 µm - 3 mm (continuously adjustable)
Resolution. . . . . 0.4 nm (at 435.8 nm, slit width 10 µm, 1200 g/mm grating)
Wavelength accuracy . . . . . 0.25 nm (1200 g/mm grating)
Wavelength repeatability . . . . . 0.1 nm

Excitation Sources

Light source	Pulsed LEDs (PLS Series)	Laser Diode Heads (LDH Series)		Ti:Sa Lasers
Wavelengths	255 - 600 nm	375 - 510, 530, 635 - 1550 nm		240 - 950 nm[2)]
Pulse width	400 ps - 1 ns	60 - 500 ps		20 - 200 fs
Repetition rate	up to 40 MHz	up to 40 MHz (optional 80 MHz)		up to 84 MHz

Detectors

Type*	PMT (PMA-C Series)	MCP-PMT		NIR-PMT
Spectral range	185-820 nm, 300-850 nm, 300-900 nm	160-650 nm, 160-850 nm		950-1400 nm
Dark counts (at 20°C, typ. value)	< 50 cps < 300cps	< 900 cps	< 50 cps < 500 cps	< 10,000 cps

Data Acquisition

Type	PicoHarp 300		NanoHarp 250
Time resolution (bin width)	4 ps		4 ns, 32 ns
Count depth	16 bit		18 bit
Dead time	< 95 ns		8 ns
Lifetime resolution	< 10 ps		< 10 ns
Time channels per curve	up to 65536		1024 to 262144
Differential non-linearity	< 1 % rms, < 5 % pp		< 0.1 % rms, < 1 % pp
Discriminator level, zero cross adjust	software adjustable		
Collection time	1 ms - 10 h		

Data Analysis Software
Type . . . . . FluoFit Pro
Analysis possibilities . . . . . exponential decay, lifetime distribution, anisotropy, global analysis

Operation
Operating system . . . . . Windows™ XP/Vista/7

Electrical and Dimensional
Power requirements . . . . . 220/240 or 110/120 VAC, 50/60 Hz
Dimensions (standard) . . . . . 900 mm × 550 mm × 400 mm (w × d × h)

*1) with a different photon counting board, 2) incl. harmonics, * other types available upon request*

Further PicoQuant Systems

FluoTime 100
Compact fluorescence lifetime system

MicroTime 100
Upright time-resolved fluorescence microscope

MicroTime 200
Inverse time-resolved fluorescence microscope

LSM Upgrade Kit
Compact lifetime & FCS upgrade kit for Laser Scanning Microscopes

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