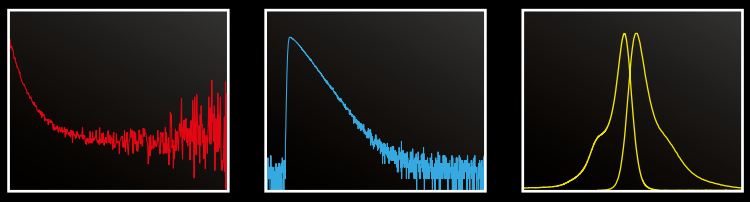
PicoQuant

FluoTime Series

Photoluminescence spectrometers
for beginners and experts



Your Benefits

High quality spectroscopy for all skill levels

The time-resolved spectrometers from our FluoTime Series enable even novices to perform complex measurements thanks to hardware automation and a control software that provides step-by-step guidance through the experiment. Expert users can gain full control over every aspect of the instrument and its software. Having been developed by scientists for scientists, the FluoTime Series is sure to be the perfect fit for your laboratory.

- **Fully automated with software control**
  Adjust hardware aspects through the system software
- **Large versatile sample chamber**
  Broad variety of easily exchangeable sample holders
- **For novice and expert users alike**
  Let our software wizards guide you or gain full control with the customized and scripting modes
- **One stop software solution**
  Measure and analyze data through a single interface
- **Modular and flexible design**
  Adapt the FluoTime to your requirements

FluoTime 250

The essentials for time-resolved spectroscopy

The FluoTime 250 integrates all essential optics and electronics for time-resolved photoluminescence spectroscopy into a compact, fully automated device.

PicoQuant's long standing experience with pulsed excitation laser sources and time-correlated single photon counting forms the basis for the instrument's design. The FluoTime 250 aims to assist the user in carrying out routine as well as complex measurements quickly and with high reliability. This is achieved through fully automated hardware components and a versatile system software featuring wizards that provide step-by-step guidance. Advanced users can get full control over all aspects of the spectrometer thanks to a customized mode and integrated scripting language.

Customizable

In its basic configuration, the FluoTime 250 uses a motorized filter wheel for emission wavelength selection. An optional monochromator for the UV/VIS spectral range is available. A selection of detectors as well as broad range of pulsed diode laser or LEDs can be attached to the spectrometer as excitation sources. The FluoTime 250 can be further adapted to the users requirements via a series of accessories and easily exchangeable sample holders.

High sensitivity

Despite its small footprint, the FluoTime 250 is very sensitive: it can reliably detect the fluorescence decay of samples with concentrations down to 10 pMol (measured on a coumarin sample).

- *Compact design with full automation*
- *Detection in the UV / VIS range with single photon sensitivity*
- *Broad selection of pulsed excitation sources (lasers and LEDs)*
- *Large multifunctional sample chamber*
- *Optional emission monochromator*

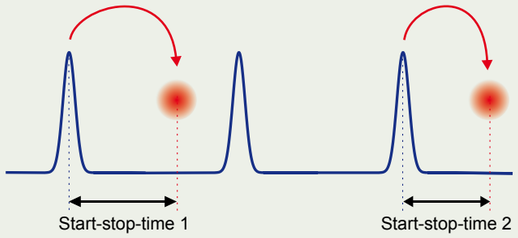
Versatile sample mounting units

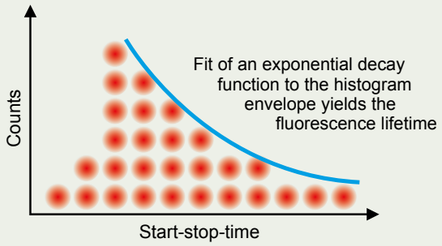
The large sample chamber of the FluoTime 250 makes it easy to investigate different types of samples, just by using special designed mounting units. Each sample mounting unit is designed around modular sample holders (standard: cuvette, optional: solid sample holder), which allow quick and easy change between different sample configurations. Even a liquid nitrogen cryostat can be integrated for measurements at low temperatures.

"The new FluoTime 250 is the result of PicoQuant's long standing experience: It provides an easy way to perform time-resolved studies with a compact and robust system."

Zygmunt "Karol" Gryczynski, Department of Physics and Astronomy, Texas Christian University

Principle of lifetime measurement





Spectrometers from the FluoTime Series measure the lifetime using Time-Correlated Single Photon Counting (TCSPC). This technique is based on the precise measurement of the time difference between excitation and arrival of the first fluorescence photon at the detector. The time difference measurement is repeated many times to account for the statistical nature of fluorescence emission. All measured time differences are sorted into a histogram, which can then be analyzed to extract the fluorescence lifetime.

FluoTime 300

The flexible photoluminescence platform

The FluoTime 300 is a high-end photoluminescence spectrometer with a modular design and fully automated hardware. It is capable of performing a huge variety of steady-state and time-resolved measurements, with outstanding flexibility in both the spectral (UV to NIR) as well as time range (from ps to ms).

Designed for flexibility and accessibility

The core philosophy behind the FluoTime 300 is to enable both novice and expert users to carry out photoluminescence spectroscopy ranging from routine measurements to highly sophisticated applications. The fully automated hardware and powerful system software EasyTau 2 ensures that the user is clearly guided through the experiment, while always having the option for full control over all instrumental parameters.

Outstanding sensitivity

The system is built for maximum light throughput as well as highest sensitivity and timing precision. These goals are achieved by carefully designing and selecting all optical components and TCSPC electronics used in the FluoTime 300. It is thus capable of reaching a signal-to-noise ratio up to 29.000 : 1 (water Raman signal).

Customize it!

Thanks to its modular design, the FluoTime 300 can be adapted to the user's requirements: A large selection of steady-state and pulsed excitation sources (lasers, LEDs, Xe lamps), monochromators as well as detectors are available.
The optional double monochromators in emission can be operated in either additive (increased spectral resolution) or subtractive (improved temporal resolution) mode. Switching between modes is easily done via software.
At the heart of the FluoTime 300 is a large multifunctional sample chamber that can accommodate a broad range of sample holders for solids, powders, or liquids.

- *Wide range of multifunctional sample holders*
- *Motorized single or double monochromator for excitation and emission pathways*
- *Single photon sensitive detection in the UV / VIS and NIR ranges*
- *Accommodates up to two detectors*
- *Switchable modes for double monochromator in emission*
- *Large choice of excitation sources: from pulsed lasers and LEDs to xenon arc and flash lamps*

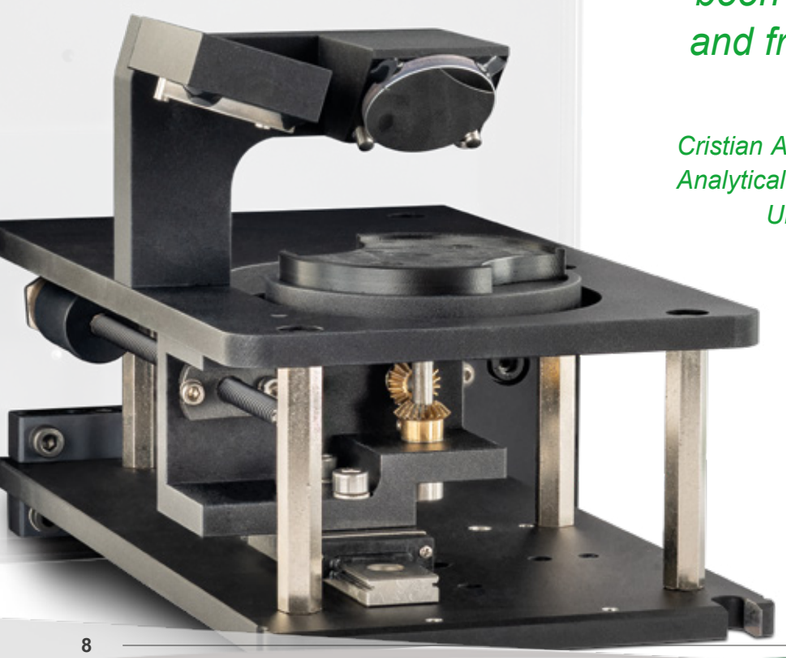
Modular Sample Holders

Put your sample into the spotlight

The FluoTime's large multifunctional sample chamber can accommodate a wide range of holders, so that various types of solids, powders, and liquids can be investigated in an elegant manner. Switching between holders is as simple as it can be: just pull it out of the instrument and insert another one! Our specially designed sample holders enable an unprecedented flexibility in investigating any sample under various conditions.

Specialized sample holders

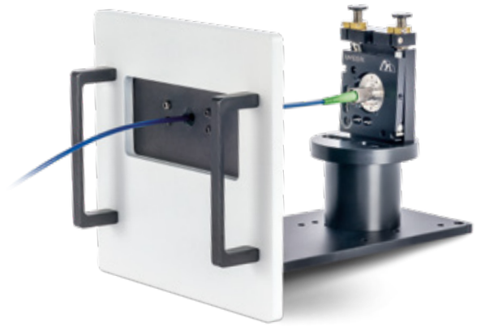
The large multifunctional sample chamber of the FluoTime spectrometers can accommodate a wide variety of specialized sample holders. Their modular design allows an easy and on-the-fly switching between mounting units, offering unprecedented flexibility in measuring liquid, solid, or powder samples under a wide range of conditions. Special holders can also be designed to fulfill specific needs. Feel free to contact us with your requirements.



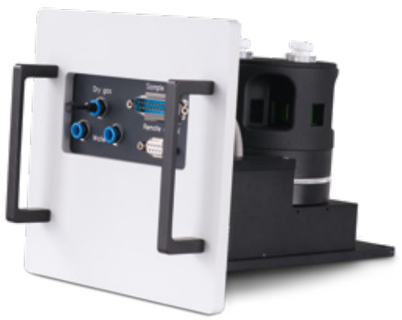
"The FluoTime 300 has been our reliable "working horse" and partner for almost six years now, it is a powerful and versatile tool. The real-time support from PicoQuant has been always fast, competent and friendly every single time we needed it."

Cristian A. Strassert, Institute of Inorganic and Analytical Chemistry, Westfaelische Wilhelms-University Muenster, Germany

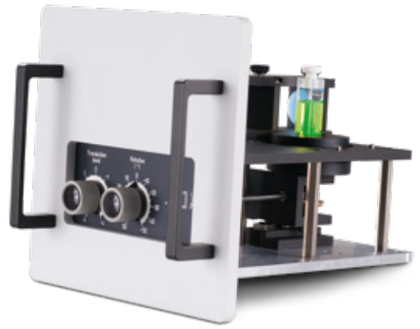
Wafer-check sample holder for investigations of 2 Inch wafers and flat samples.



Sample holder with fiber coupler to interface an optical microscope with the FluoTime spectrometer.



Peltier cooled sample mounting unit with motorized 4-position holder for 1 by 1 cm cuvettes with a temperature range from -15 to 110 °C.



Adjustable front face sample holder for characterizing luminescence properties of solids, powders, films, coatings, or wafers.

EasyTau 2

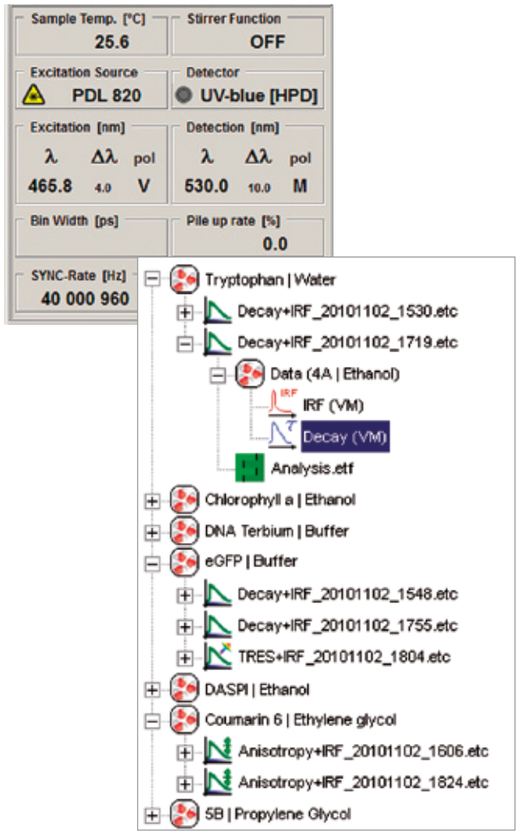
Unified interface for measurement and analysis

The EasyTau 2 software combines full hardware control for a FluoTime Series spectrometer with an interactive data analysis and fitting module in a single package. A well-organized workspace stores all measured data along with their related analysis results in a hierarchical tree structure. All relevant system and acquisition settings are logged for each measurement, including the current user name, which is invaluable for multiuser facilities. The analysis and fitting module supports a broad range of methods.

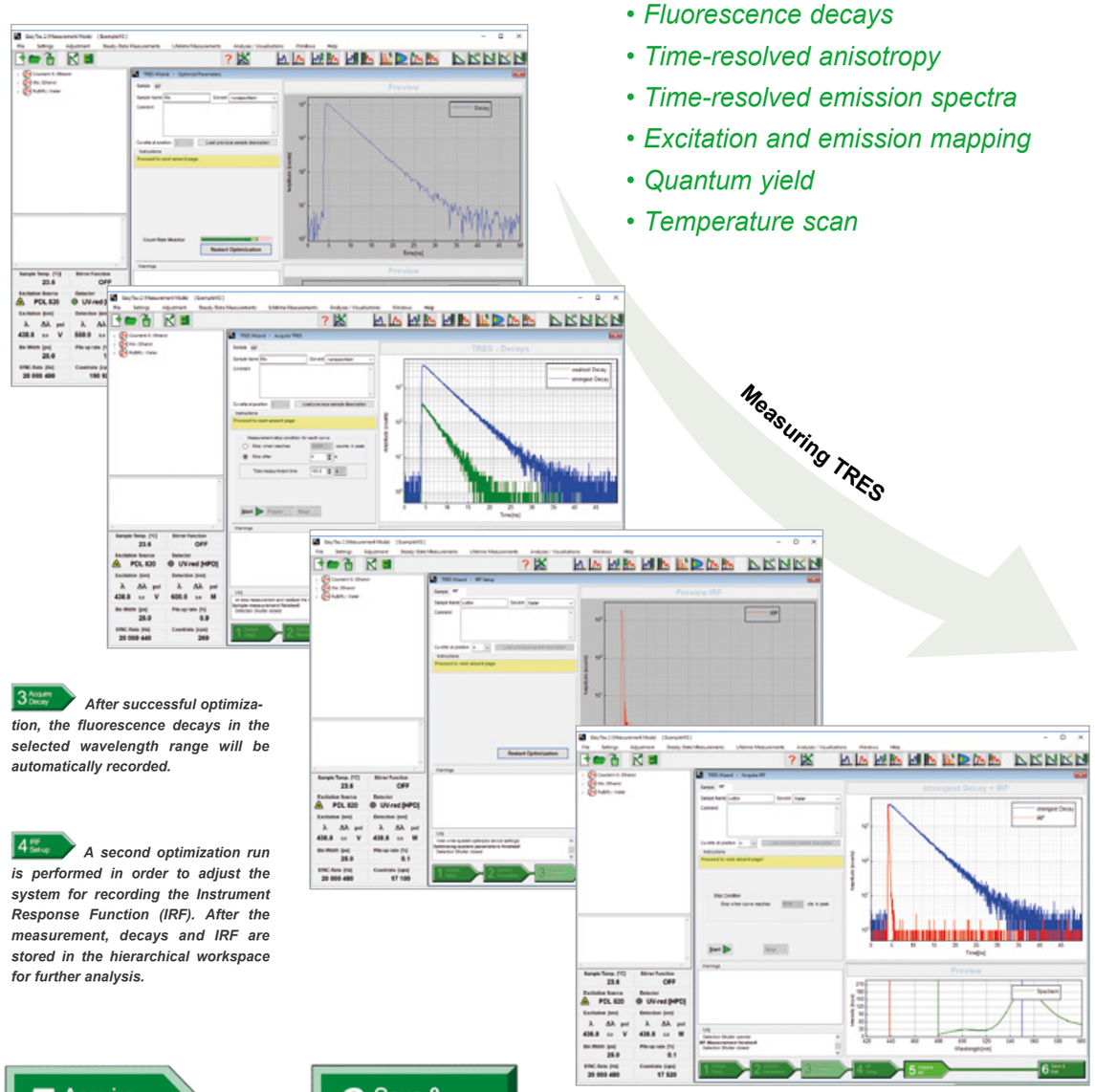
The EasyTau 2 interface is designed to provide a quick way for controlling all components of the FluoTime spectrometer. The clear graphical layout allows access to all settings via simple mouse clicks.
The software features specially designed application wizards that guide users through all steps. Thus, even novice users can acquire high quality data from experiments such as:

- Steady-state excitation, emission or anisotropy
- Emission decays and time-resolved anisotropy
- Time-Resolved Emission Spectra (TRES)
- Quantum yields
- Time-traces experiments
- Temperature dependant scans

A customized measurement mode is available for advanced users, that enables automating complex applications, such as alternating between measuring time-resolved decays and steady-state spectra at different temperatures. Automation can be extended to third-party accessories like robotic autosamplers thanks to an interface for remote script execution.



2 Optimize Parameters — The wizard automatically optimizes the spectrometer for best performance by varying signal intensity, temporal resolution, laser repetition rate, etc.



3 Acquire Decay — After successful optimization, the fluorescence decays in the selected wavelength range will be automatically recorded.

4 IRF Set-up — A second optimization run is performed in order to adjust the system for recording the Instrument Response Function (IRF). After the measurement, decays and IRF are stored in the hierarchical workspace for further analysis.

WIZARDS INCLUDED

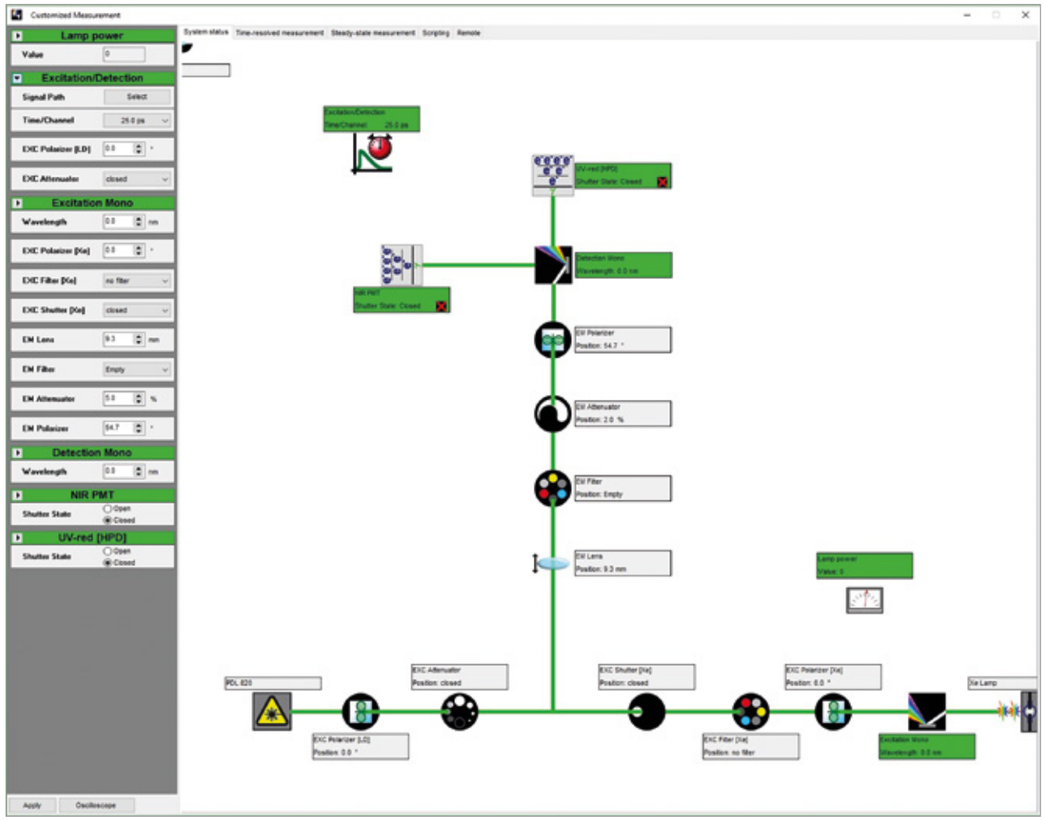
- *Excitation and emission spectra*
- *Excitation and emission anisotropy*
- *Intensity and lifetime kinetics*
- *Fluorescence decays*
- *Time-resolved anisotropy*
- *Time-resolved emission spectra*
- *Excitation and emission mapping*
- *Quantum yield*
- *Temperature scan*

1 Sample Set-up → 2 Optimize Parameters → 3 Acquire Decay → 4 IRF Set-up → 5 Acquire IRF → 6 Save & Exit

EasyTau 2

A single software for measurement and analysis

Performing photoluminescence experiments is often considered to be best left to experts. However, the software wizards included in the EasyTau 2 can guide even novices through these tasks. Additionally, power users can have unprecedented control over the instrument via the “customized mode” and scripting language.

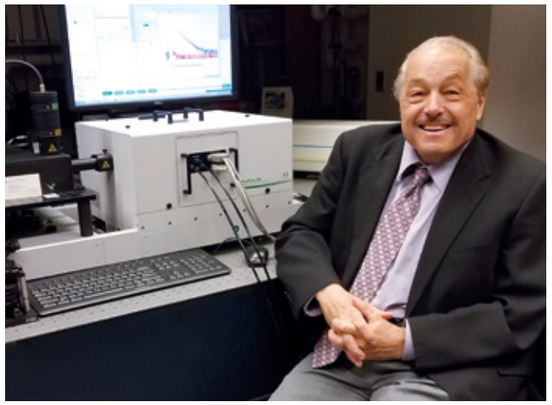


Customized measurement mode

Expert spectroscopists can gain full control over the instrument with the EasyTau 2 software. When using “customized measurement” mode, the user can adjust settings for every component in the excitation and detection pathway, including polarizer position, attenuator as well as shutter state.

Scripted data acquisition

In addition to the full instrument control in “customized measurement” mode, EasyTau 2 features a scripting language. This versatile scripting language allows creating user-defined measurement protocols for time-resolved or steady-state experiments in a convienent way: Programming novices can generate script lines by simply clicking on a component and setting the desired value.



“The FluoTime 300 makes time-resolved measurements accessible to all laboratories.”

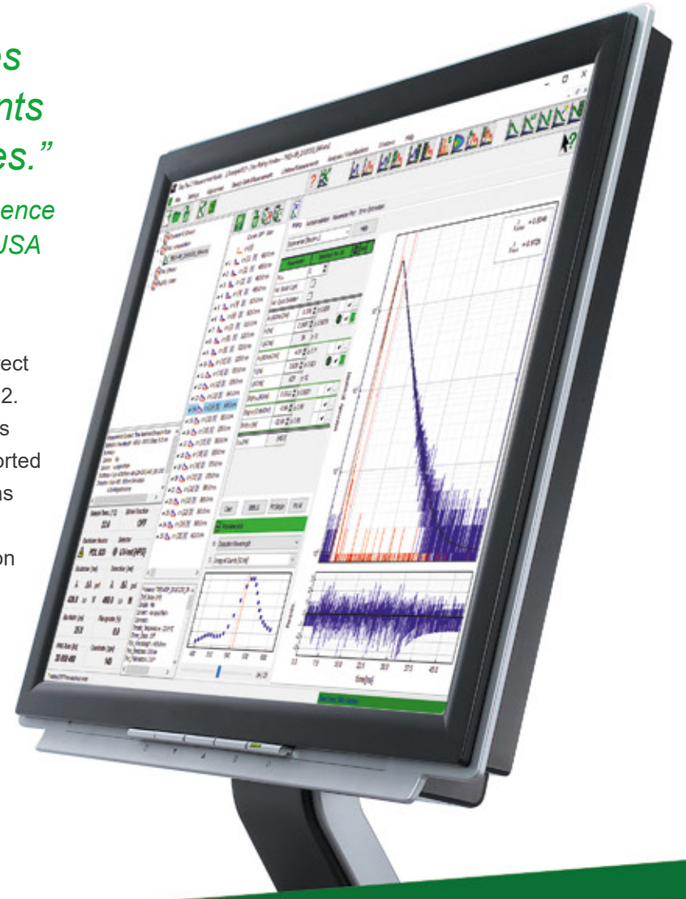
Joseph R. Lakowicz, Center for Fluorescence Spectroscopy, University of Maryland, USA

Multi-exponential decay analysis

For analysis of time-resolved measurements, a direct data analysis function is implemented in EasyTau 2. Fluorescence decay and anisotropy measurements along with powerful global data analysis are supported by the integrated fitting algorithm using tail fitting as well as numerical reconvolution with up to 5 exponential functions. Anisotropy analysis of polarization dependent measurements is included as well as different lifetime distribution models that can be fitted to the acquired data. Reduced chi-square, weighted residuals, and autocorrelation traces can be used to assess the goodness of fit. Advanced error analysis using bootstrap analysis assigns realistic confidence intervals to the fitted parameters.

Broad range of data arithmetic

EasyTau 2 offers processing and analysis of experimental data through a powerful mathematical function processor. Different operations such as spectra subtractions or smoothing, derivatives, integrations, or normalization can be applied on either experimental data results or previous calculations. Plots can be freely zoomed, and all measurement or analysis results can be exported as presentation-ready images or as multicolumn ASCII data for further processing.

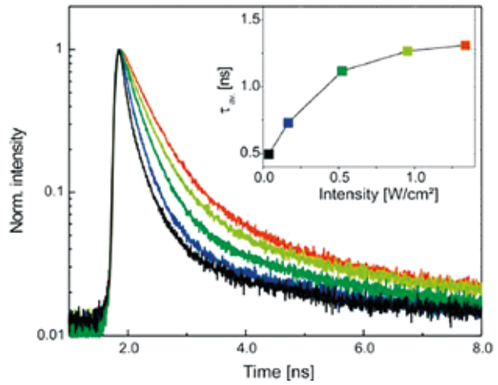


Emission Spectroscopy

A modern way to gather more information

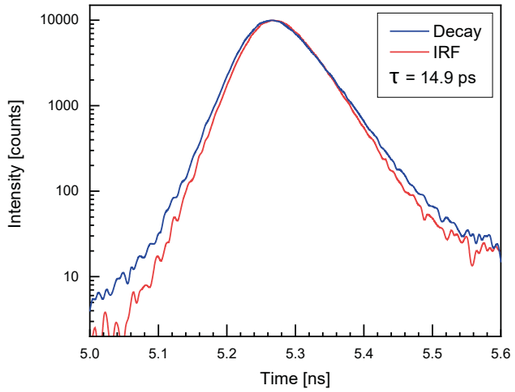
Charge carrier dynamics in semiconductors

Charge carrier dynamics in semiconductors are determined by the architecture and function of the respective device and directly relate to the nature and quality of wafer materials. In this example, the luminescence lifetime of an GaAs based quantum well was measured at 635 nm excitation using different excitation intensities. The results show a lifetime increase at higher excitation powers.
Sample courtesy of Andrea Knigge, Ferdinand-Braun-Institute, Berlin (Germany)



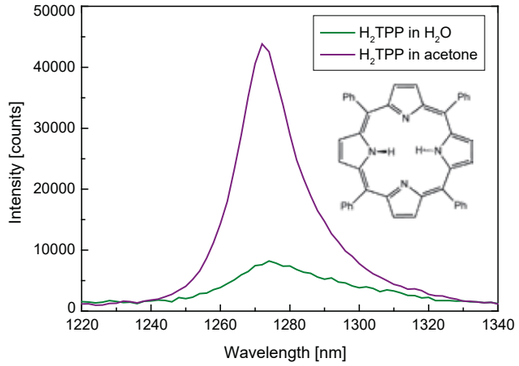
Determination of lifetimes shorter than the instrument response

The FluoTime spectrometers are capable of measuring fluorescence lifetimes that are shorter than Instrument Response Function (IRF). In this example, the decay of solvent relaxion was recorded and the reconvolution fit yielded a lifetime of 15 ps, which is shorter than the IRF (55 ps).



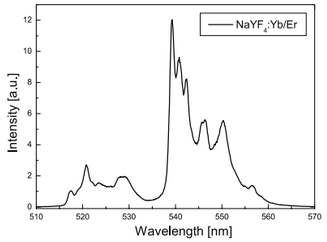
Quantifying singlet oxygen generation

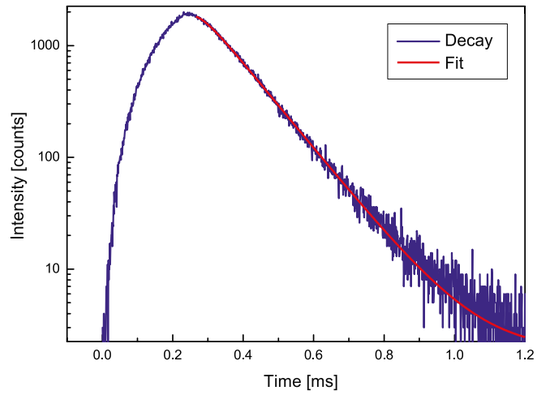
Spectrometers from the FluoTime Series support burst mode excitation, which is highly valuable when studying long lived luminescent species such as singlet oxygen (with a lifetime of ca. 3.4 µs in acetone), using high repetition rate excitation lasers. The example shows the steady-state spectrum of the singlet oxygen emission produced by H_2TTP in acetone and even in H_2O, which is especially challenging due to the spectral overlap of water and singlet oxygen emission.



Fluorescence upconversion of nanoparticles

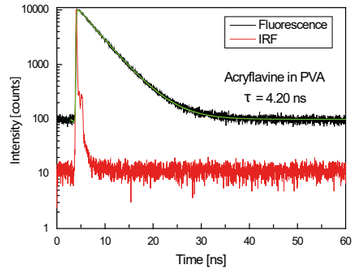
Fluorescence upconversion occurs when a material absorbs two photons of the same wavelength (usually in the NIR) and then emits light at shorter wavelengths. Such materials are currently investigated for future applications as probes for in vivo optical imaging or as sensitizers to improve solar cell efficiency. The FluoTime Series can be equipped with detectors that cover various spectral ranges form the NIR to the UV, making it ideal for studying such materials.

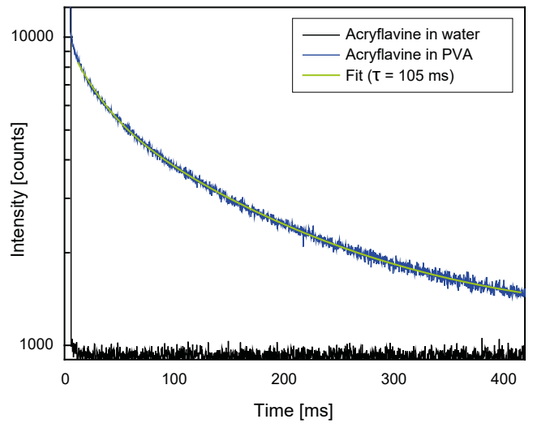




Thermally activated delayed fluorescence

The FluoTime spectrometers are capable to measure short and long luminescence lifetimes in a single set-up. A good case study is acroflavine in PVA films where both fluorescence and thermally activated delayed fluorescence can occur. Upon excitation, the sample shows normal emission (with ns lifetime, right image) and delayed fluorescence upon thermal activation (with lifetimes in the ms range, lower image).



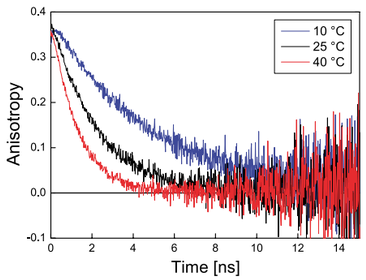


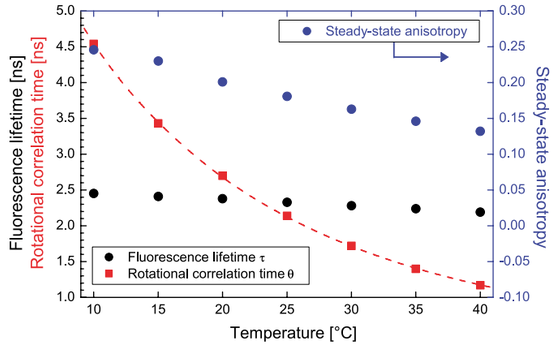
Anisotropy and Quantum Yield

Get more valuable information from your sample

Dynamic anisotropy

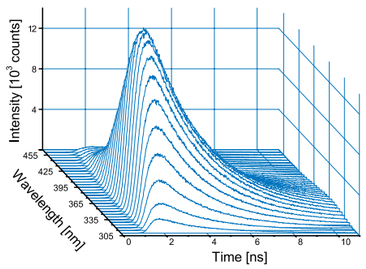
In this example, the emission anisotropy decay of coumarin 6 in ethylene glycol was recorded at various temperatures. As expected, the model of a single, spherical rotating particle with monoexponential lifetime can be perfectly fitted to the experimental data. The fluorescence lifetime shows only a slight temperature dependence, while the temperature induced viscosity as well as rotational energy changes can be perfectly fitted to the observed rotational correlation times.

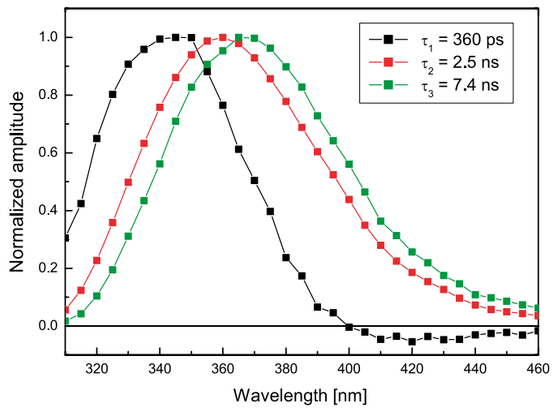




TRES of tryptophan

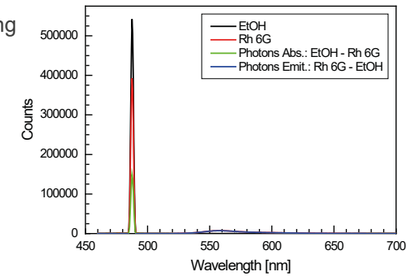
Thanks to their automation capabilities, spectrometers from the FluoTime Series enable users to perform even complex experiments such as Time-Resolved Emission Spectra (TRES) in an efficient and simple manner. As an example, a solution of tryptophan in a saline buffer was excited with a pulsed LED. A total of 31 decay curves were automatically collected and the global analysis reveals that they can be well described with three lifetimes: 360 ps, 2.5 ns, and 7.4 ns.

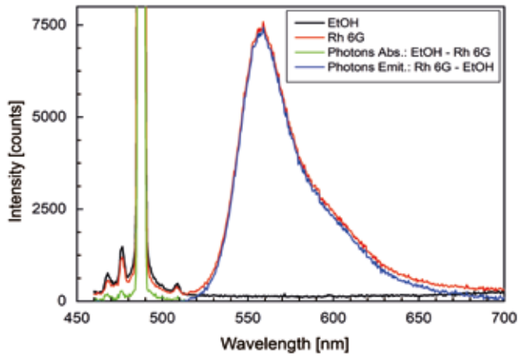




Luminescence quantum yield measurements

Luminescence quantum yields are critical to understand the excited state behavior of a sample and its interaction with the environment. The FluoTime 300 can be outfitted with an integrating sphere for measuring absolute quantum yields for solids or liquids. A dedicated application wizard in the EasyTau 2 guides users step-by-step through the process, keeping the workflow simple.





"PicoQuant supplies by far the best time-resolved fluorescence and fluorescence anisotropy turnkey systems out there."

Thomas Just Sørensen, Nano-Science Center and Department of Chemistry, University of Copenhagen, Denmark

Integrating sphere for quantum yield measurements of scattering samples, solutions as well as solid samples. The complete work flow for quantum yield determination is included in the EasyTau software as a dedicated wizard which then becomes a routine task taking only a few minutes to complete.

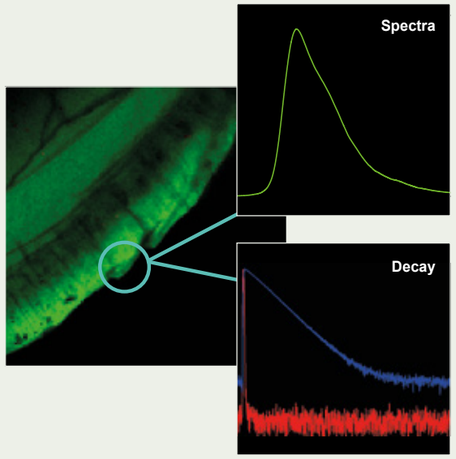
For Materials Science

Discover what is emitting from where in your sample

PicoQuant offers a solution that combines a steady-sate and time-resolved spectrometer from the FluoTime Series with a scanning microscope like the MicroTime 100. This type of set-up is a powerful tool for investigating, e.g., excited state dynamics and processes.

Thanks to its sample holder with fiber coupling, the FluoTime Series can be interfaced with a scanning microscope such as the MicroTime 100. This kind of set-up allows users to easily record time- and space-resolved photoluminescence spectra from any sample mounted under the microscope.
Expanding the capabilities of a spectrometer with a microscope's ability to probe and scan small areas provides exciting opportunities for investigating the spatial dependence of luminescence behavior in a large variety of samples including, e.g., localizing and characterizing structural defects in semiconductor materials such as Copper Indium Gallium (di)Selenide (CIGS) used in solar cell research.
Such a combination is also of great value to analytical facilities in research centers, as it offers an expanded range of possible spectroscopic and microscopic applications in a single, convenient set-up. When equipped with double monochromators, hybrid detectors, versatile TCSPC units with short and long time ranges, and pulsed lasers capable of working in burst mode, the set-up offers a combined solution meeting most of the high demands with regards to time, spectral, or spatial resolution in the fields of Chemistry, Biology, Physics, as well as in Life, Material or Environmental Sciences.

Example



By combining a scanning microscope with a time-resolved spectrometer, it is possible to obtain spatial, spectral and lifetime information from the same sample area. The large FLIM picture on the left shows a dye-labeled artificial fiber that was studied using a MicroTime 100 coupled to a FluoTime 300. The two insets on the right display the recorded emission spectrum (top) and fluorescence decay curve (bottom) recorded from the marked spot in the FLIM image.

Capabilities

	FluoTime 250	FluoTime 300
Fully automated system	●	●
Modular sample chamber	●	●
Picosecond pulsed excitation sources (LDH, PLS Series)	●	●
Continuous wave excitation (Xe lamp)		●
Sub-microsecond pulsed Xe flash lamp		●
Laser systems (VisUV / VisIR)		●
Emission monochromator	optional	●
Excitation monochromator		for cw sources
Double monochromators (emission and / or excitation)		optional
Number of simultaneously connected detectors	1	2
Detector types:		
Photomultiplier Tubes (PMTs)	●	●
Hybrid PMTs	●	●
Microchannel Plate PMTs (MCP-PMTs)		●
Detection range:		
UV / VIS	●	●
NIR	optional	●
Covered lifetime ranges	from ps to ms	from ps to ms
Time-resolved spectroscopy	●	●
Steady-state spectroscopy		●
Anisotropy analysis	●	●
Quantum yield measurements		●
Temperature controlled (Peltier, cryostat)	●	●
One-stop data acquisition and analysis software	●	●
Software (wizards) assisted measurements	●	●

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