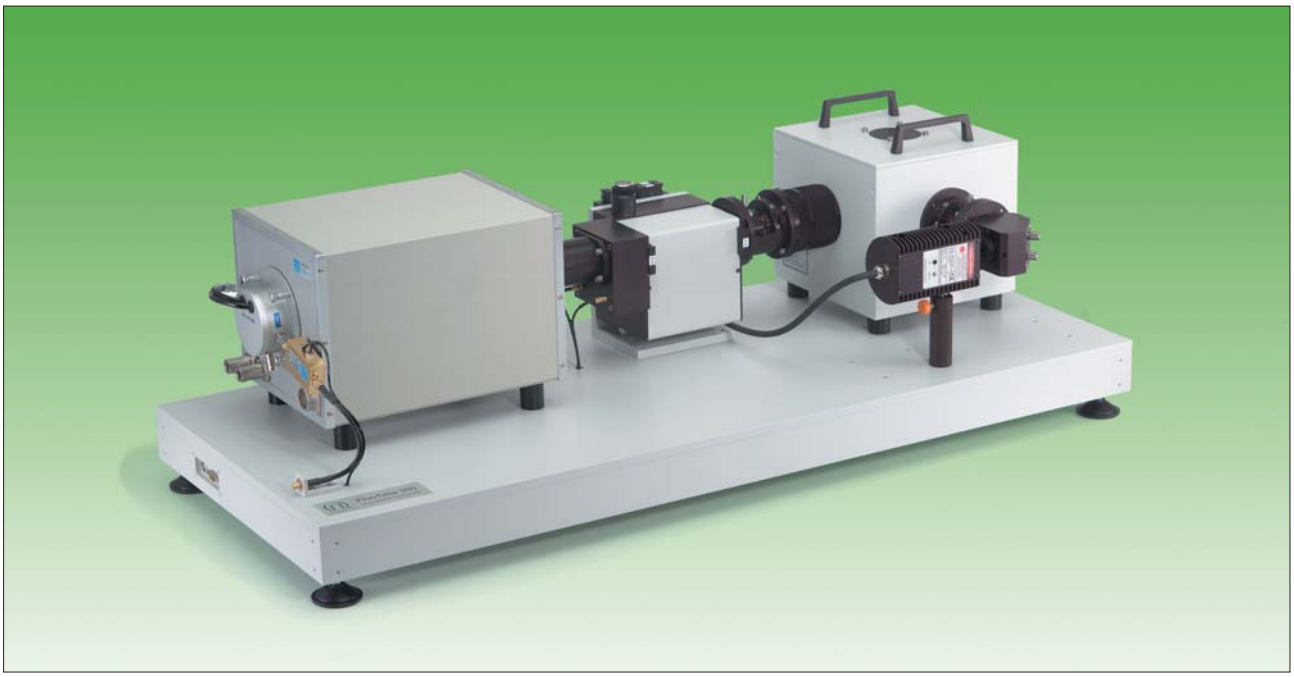
# FluoTime 200

PicoQuant

## High Performance Fluorescence Lifetime Spectrometer

- Modular and flexible design
- Picosecond time resolution
- Time-Correlated Single Photon Counting (TCSPC) via USB
- Laser injection optics
- Optional prism polarizers
- Advanced data analysis software



## Applications

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

# Configuration and Standard Components

The FluoTime 200 spectrometer is a high performance fluorescence lifetime system featuring modular construction, single photon timing sensitivity and research flexibility. It contains the complete optics and electronics for recording fluorescence decays by means of Time-Correlated Single Photon Counting (TCSPC). The system can be used with femtosecond or picosecond lasers, like the picosecond diode lasers from PicoQuant. With the FluoTime 200, decay times down to a few picoseconds can be resolved. The system allows operation at laser repetition rates as high as 85 MHz and count rates up to several million counts/sec.

**Laser coupling module**

The laser coupling module consists of an iris, a beam steering mirror, an optional replaceable polarizer module and a focusing lens. The iris allows precise adjustment of the excitation intensity and prevents the penetration of room light into the sample chamber. The beam is directed towards the sample by an adjustable steering mirror. An optional prism polarizer selects the desired polarization plane of the non-polarized radiation. Finally, the beam is focused onto the sample by an adjustable lens.

**Sample chamber**

The sample chamber contains a versatile sample holder (standard: cuvette, optional: front face) and a mechanism to protect the detector from excessive light exposition. Temperature control of the cuvette holder is possible by attaching an external thermostat (tubing for the circulating fluid is pre-installed) or by replacing the standard cuvette holder with a peltier-cooled holder. Later upgrades to T- or X-geometry or motorized sample holders are possible.

**Detector**

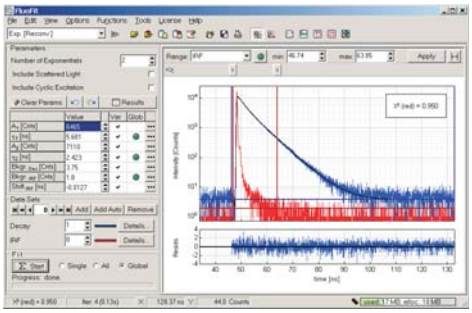
The PMA detector unit, based on the Hamamatsu H5783 series photosensor module, is recommended for the majority of applications. The unit has a built-in high voltage power supply, signal pre-amplifier and a gold plated iron housing for optimal timing performance and maximum shielding. With this detector unit, an Instrument Response Function (IRF) as short as 200 ps can be achieved. Cooling is available for both detector types to reduce the number of dark counts.

**Monochromator**

For spectral filtering of the emitted light, a small monochromator is chosen. The standard single monochromator, with a 100 mm focal length, features low time dispersion, an f/3.2 aperture and externally adjustable slits with bandwidths of 4, 8 and 16 nm.

**Data analysis**

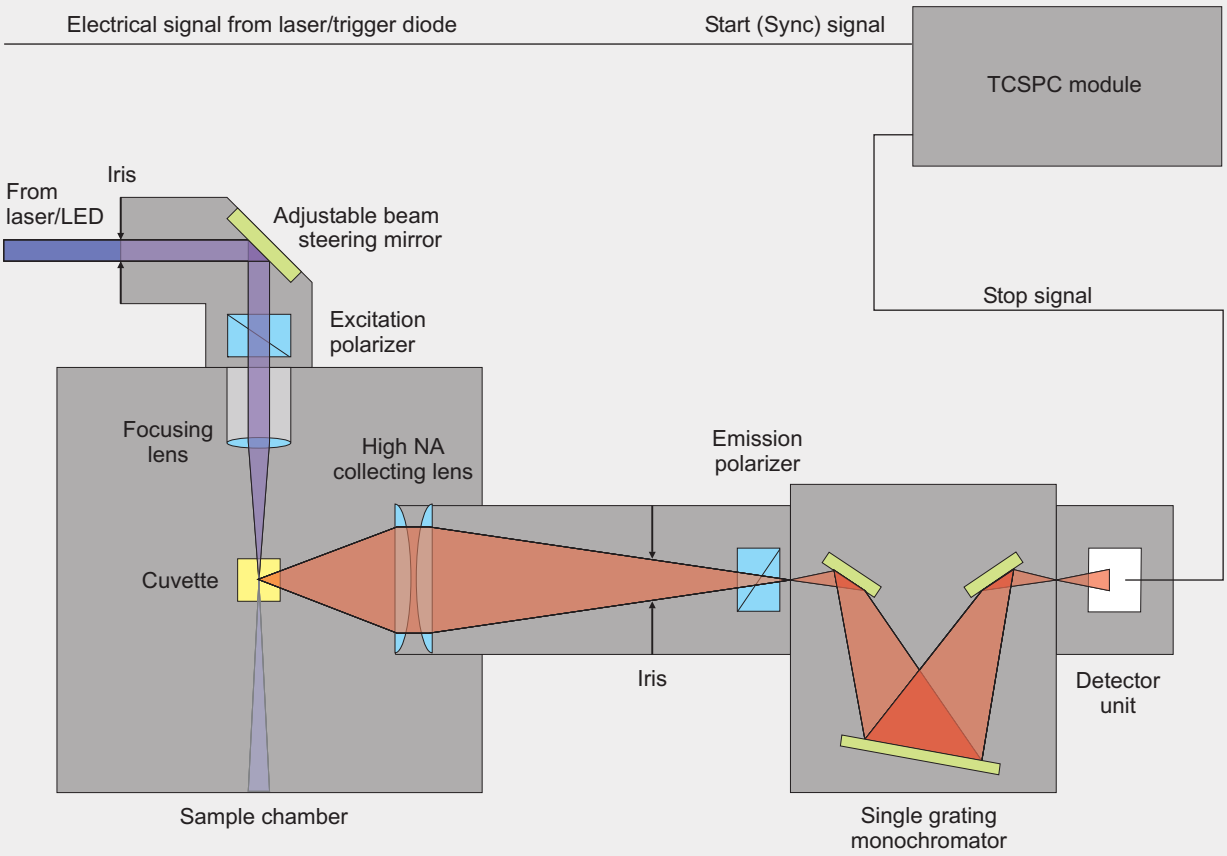
Numerical analysis of the raw data is an integral part of the TCSPC method. FluoFit is a Windows™ based global decay analysis software with an easy to use graphical user interface and presentation-ready numerical and graphical output. It implements an iterative reconvolution fitting routine with nonlinear error minimization. Various exponential decay models (up to fourth order) or rate constant distribution models can be fitted to the observed decay. FluoFit supports fitting of calculated anisotropy data as well. Running FluoFit simultaneously with the measurement software allows for parallel data analysis.



**TCSPC data acquisition**

The data acquisition module contains the complete timing electronics for Time-Correlated Single Photon Counting (TCSPC). The system works in forward start-stop mode, still operating at the full repetition rate of modern pulsed excitation sources. Several million photon events per second can be processed. Consequently, TCSPC acquisition times shorter than 1 second can be utilized. All functions of the TCSPC module are controlled by easy to use Windows™ based software. These functions include loading and saving experimental data as well as setting and storing measurement parameters. Optionally available is a data acquisition board for lower time resolution (phosphorescence decays).

# Optical Layout



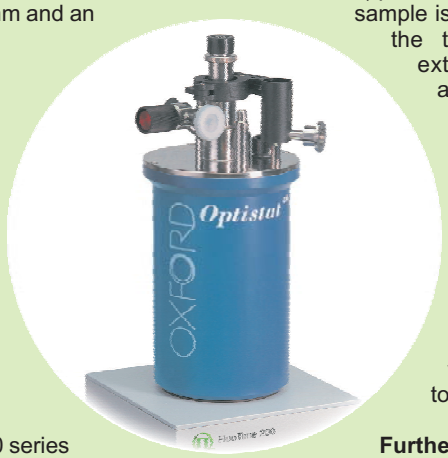
# Options

**Prism polarizers**
For fluorescence anisotropy measurements a 15 mm aperture Glan-Laser polarizer can be provided. It features an excellent transmission range of 230-2700 nm and an extinction ratio of $10^{-5}$.

**Microchannel plate PMT**
Detector based on the Hamamatsu R3809 series microchannel plate photomultiplier tube (MCP-PMT) to achieve the highest possible time resolution with the TCSPC method. With fast laser sources the IRF is less than 50 ps.

**Multichannel scaler**
For slow luminescence decays, the NanoHarp 250 multiscaler board can be added.

**NIR-PMT**
Detector based on the Hamamatsu H10330 series photomultiplier tube for fluorescence detection in the infrared up to 1400 nm (1700 nm as an option).



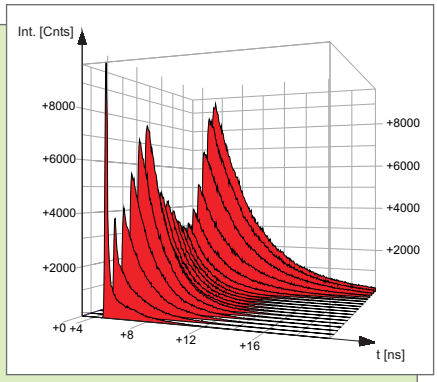

**Versatile sample holder**
The standard sample holder accommodates 1 cm (or smaller) path length cuvettes. Temperature control of the sample is made possible by circulating liquid and the tubing is pre-installed. An additional external thermostat (optional) can be attached. The cuvette holder can be optionally replaced with a peltier cooled cuvette holder or replaced with a simple front face sample holder.

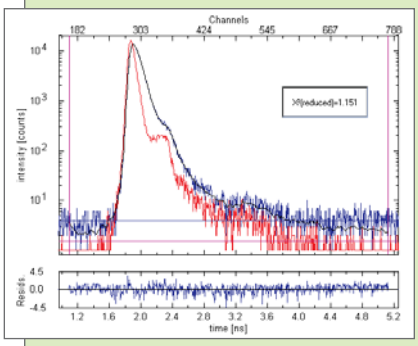
**Cryostat options**
The Oxford Instruments *Optistat*™ series cryostat allows for low temperature photoluminescence measurements. Precise control of the sample temperature is possible with various cryostat types, ranging from 2.3 to 500 K.

**Further options**
Electrical stirrer, multi-pass sample holder, DLLs for custom programming, …

# Measurement Examples

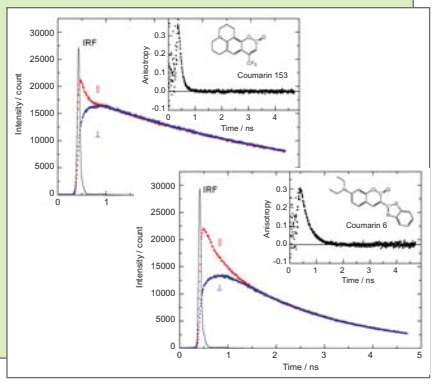
Spectral dependence of the fluorescence decay kinetics (i.e. time-resolved fluorescence spectra) of an ethanol solution of Phenoxazon 9 (Nile Red) containing a trace amount of Coumarin 152. 32 decay curves were recorded (from 450 to 750 nm in 10 nm steps) using a FluoTime 200 with motorized monochromator. The decay curves show that, at longer times, the spectra are dominated by the Nile Red emission due to its longer lifetime. This measurement mode of the FluoTime 200 is particularly useful for studying solvation dynamics, excimer or exciplex formation and related phenomena.




Time-resolved fluorescence measurement of DASPI ($10^{-6}$ molar in Ethanol) using a FluoTime 200 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.

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 200 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 compounds. 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.



# Specifications

**System**

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

**Monochromators**

| | |
|---|---|
| Type | single |
| Focal length and aperture | 100 mm F/3.2 |
| Stray light rejection | $1 \cdot 10^{-5}$ |
| Gratings | 1200 l/mm (standard) |
| Step size (min) | 0.5 nm |
| Resolution | 4 nm, 8 nm and 16 nm |
| Wavelength accuracy | 0.3 nm |
| Wavelength repeatability | 0.5 nm |

**Excitation Sources**

| | | | | |
|---|---|---|---|---|
| Light source | Pulsed LEDs (PLS Series) | Laser Diode Heads (LDH Series) | Ti:Sa Lasers | |
| Wavelengths | 245-600 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[3] | PMT (PMA Series) | | MCP-PMT | | NIR-PMT |
| Spectral range | 185-700 nm, 185-820 nm, 300-900 nm | | 160-650 nm, 160-850 nm | | 950-1400 nm |
| Dark counts* (uncooled) | < 50 cps | < 900 cps | < 6000 cps | < 50 cps | < 500 cps | --- |
| Dark counts* (cooled) | --- | < 50 cps | < 900 cps | | | < 10,000 cps |

**Data Acquisition Unit**

| | | | |
|---|---|---|---|
| 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™ 2000/XP/Vista/7 |

**Electrical and Dimensional**

| | |
|---|---|
| Power requirements | 220/240 or 110/120 VAC, 50/60 Hz |
| Dimensions (standard) | 800 × 400 × 300 mm (w × d × h) |

*[1] with a different photon counting board, [2] incl. harmonics, [3] other detectors and cooling available upon request, *typ. value at 20 °C ambient temperature*

# Other PicoQuant Systems

**FluoTime 300 "EasyTau"**
Automated fluorescence lifetime spectrometer

**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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