LifeSpec II

Lifetime Spectrometer

EDINBURGH INSTRUMENTS

The LifeSpec II is a compact, fully integrated, high performance fluorescence lifetime spectrometer designed for use with high-repetition rate pulsed femtosecond and picosecond lasers.

The system is a turn-key instrument for fundamental research and routine laboratory applications, utilising the technique of Time-Correlated Single Photon Counting (TCSPC) for accurate measurements of fluorescence lifetimes. Its zero temporal dispersion optics set the standard for technical performance in measuring ultra-fast decays, allowing the Lifespec II to measure fluorescence lifetimes down to 5 ps.

Advanced software controls all the hardware and analyses the raw data. Acquisition modes range from fluorescence or phosphorescence lifetime decay acquisitions and time-resolved spectra to automated anisotropy measurements and temperature maps.

The Lifespec II is highly configurable allowing multiple sources and detectors. Lasers ranging from fast femtosecond to compact nanosecond models, and detectors covering from the UV to the NIR range, can all be integrated in the instrument to tailor it to specific applications.

Key Features

Subtractive monochromator
Zero dispersion for ultimate temporal resolution

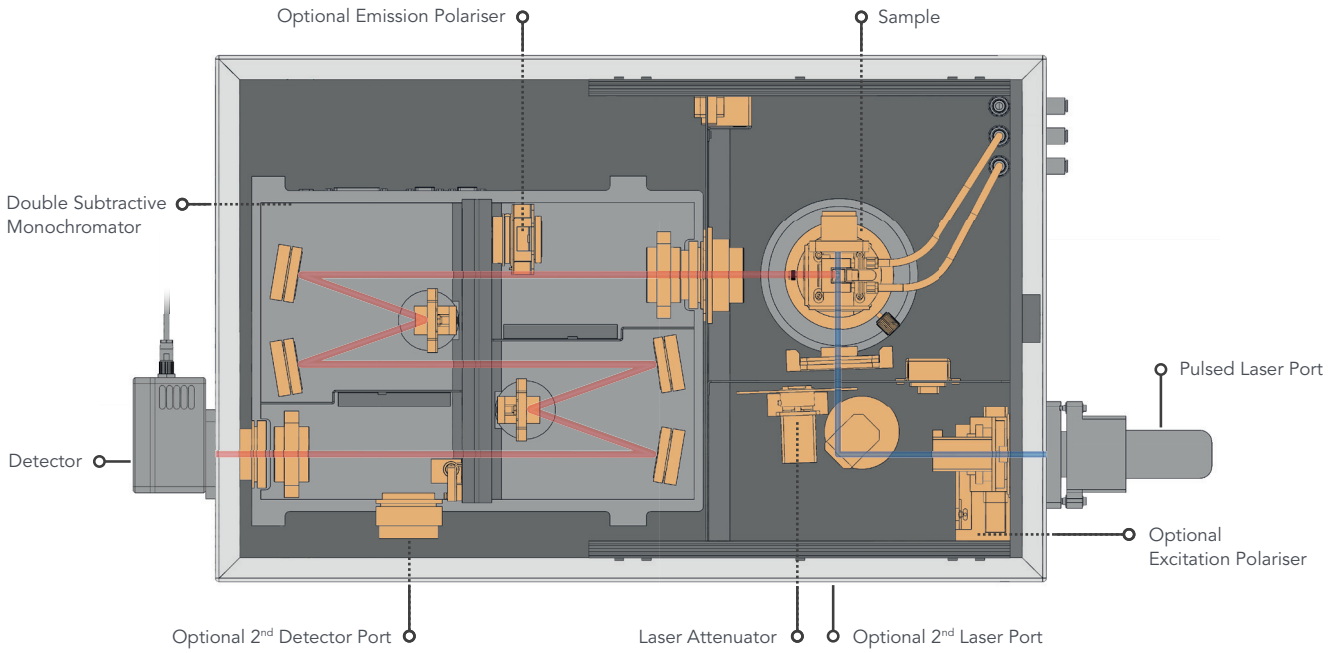
Fastest TCSPC
Market-leading electronics for fluorescence lifetimes down to 5 ps

Two detectors
Extended spectral coverage up to 1650 nm

Multi-laser integration
Two ports for coupling standard or custom lasers

MCS Upgrade
Option for phosphorescence lifetimes (µs – s)

SYSTEM OVERVIEW



PRINCIPAL LAYOUT

The complete LifeSpec II spectrometer comprises the optical spectrometer, a power supply module and a data acquisition electronics module, the TCC2. In the standard configuration, the LifeSpec II is fitted with one selected light source and one detector. The system can be upgraded with additional sources, detectors, polarisers, sample cooling stages, and fibre optics.

The LifeSpec II main unit is height adjustable, so that the optical plane can be set to between 130 mm to 180 mm from the table top. This simplifies beam steering and coupling of complex external laser systems to the LifeSpec II.

SAMPLE CHAMBER

The LifeSpec II has a large sample chamber that enables a variety of sample holder options to be fitted easily. These include single cuvette holders, multiple sample holders, front face film/bulk/powder holders, fibre attachments, thermostated sample holders and cryostats.

SUBTRACTIVE DOUBLE MONOCHROMATOR

Zero temporal dispersion in the optical path is a necessity for precise measurements in the lower picosecond time scale. Conventional monochromators introduce temporal shifts and pulse broadening originating from propagation delays caused by the dimensions of the grating. The design of the LifeSpec II uses two coupled monochromators with opposite pulse broadening characteristics. This eliminates temporal delays and temporal dispersion and enhances the stray light rejection. In this manner sources of errors in the response of the instrument are reduced and lifetime measurements can be performed and analysed more accurately.

COMPUTER-CONTROLLED POLARISERS

Motorised mounts are used both in the excitation beam path and in the emission path to operate the optional Glan Thompson polarisers. An excitation polariser may not be needed if the laser's emission is naturally polarised, which is the case for Ti:Sapphire and picosecond-pulsed diode lasers. Linearly polarised excitation and emission is a necessity for fluorescence anisotropy measurements. However, even for precise fluorescence decays (energy relaxation), polarisers may be required to eliminate rotational artifacts that are superimposed on the fluorescence decay ("magic angle" measurements).

LIGHT SOURCES AND DETECTORS

The LifeSpec II spectrometer can be used with all modern high repetition rate pulsed sources, such as picosecond pulsed diode lasers and LEDs, supercontinuum "white" picosecond pulsed lasers, and femtosecond Ti:Sapphire lasers.

The standard LifeSpec II comes with an adjustable receptor flange for picosecond pulsed diode lasers (EPL Series, HPL Series) and UV-LEDs (EPLED Series).

A supercontinuum laser can be fitted with a special wavelength selection package that allows computer controlled wavelength and spectral bandwidth selection. This package also has an integrated and optimised laser synchronisation trigger pick-up.

Alternatively, radiation of Ti:Sapphire lasers with frequency doubling / tripling and pulse picker can be used for sample excitation. A trigger pick-up accessory is available.

The shortest measurable lifetime is dependent on the speed of the detector and on the pulse width of the picosecond pulsed light source. By applying numerical reconvolution, lifetimes as short as 1/10th of the system's instrumental response function can be extracted from the data. The table shown is a guide for the time resolution that can be achieved with the LifeSpec-II using different light source – detector combinations. The figures given in the table represent the width (FWHM) of the response function of the overall system, in units of ps. The shortest possible lifetime that can be measured is estimated by dividing the figure by ten.

		WAVELENGTH COVERAGE	DETECTOR RESPONSE WIDTH	DARK COUNT RATE
DETECTORS	High Speed Blue PMT	230 nm – 650 nm	180 ps	<100 cps
	High Speed Red PMT	230 nm – 850 nm	180 ps	<150 cps
	MCP-PMT	230 nm – 850 nm	<25 ps	<10 cps
	NIR-PMT-1700 (LN_2)	500 nm – 1700 nm	800 ps	<200,000 cps
	NIR-PMT-1700 (TE)*	950 nm – 1700 nm	400 ps	<200,000 cps

		TI:SAPPHIRE LASER	PICOSECOND PULSED DIODE LASER (EPL)	PICOSECOND PULSED LED (EPLED)	SUPERCONTINUUM WHITE LIGHT LASER
INSTRUMENT RESPONSE FUNCTION (IRF)	High Speed Blue PMT	<250 ps	<300 ps	<1.0 ns	<300 ps
	High Speed Red PMT	<250 ps	<300 ps	<1.0 ns	<300 ps
	MCP-PMT	<50 ps	<130 ps	<1.0 ns	<300 ps
	NIR-PMT-1700 (LN_2)	<800 ps	<800 ps	<1.5 ns	<800 ps
	NIR-PMT-1700 (TE)*	<400 ps	450 ps	<1.0 ns	<450 ps

* The TE cooled version of the NIR-PMT cannot directly measure an Instrument Response Function below 950 nm.

The shortest recoverable lifetime (lifetime resolution) is approximately 1/10th of the Instrument Response Function after numerical reconvolution.

SOFTWARE AND SPECIFICATIONS

MEASUREMENT AND ANALYSIS CAPABILITIES

Data Acquisition Modes

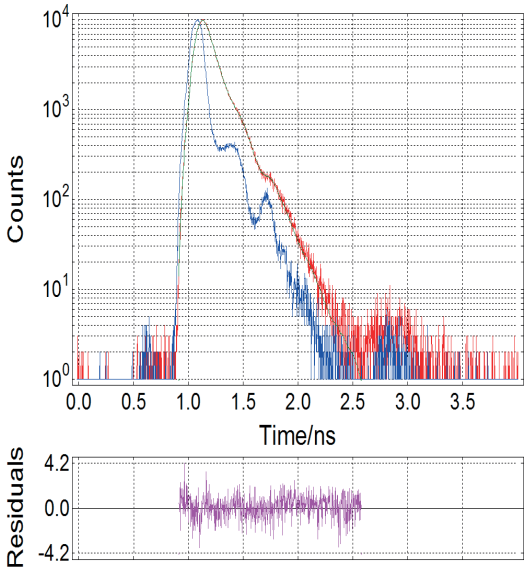
- Fluorescence Decay Acquisition.
- Time-Resolved Fluorescence Spectra.
- Quasi-Steady State Spectra (with spectral correction).
- Automated Time-Resolved Anisotropy Measurements (with optional polarisers).
- Automated Temperature Maps (with optional cryostat or Peltier cooled sample holder).

Advanced Data Analysis (optional)

- 4-exponential fit with background, shift, reconvolution, no initial guesses required.
- Lifetime Distribution Analysis with a grid of 200 lifetimes.
- Batch Analysis.
- Global Analysis.
- Förster Kinetics.
- Micellar Quenching Fits.
- Extended Expotential Components Analysis.
- Advanced Fluorescence Anisotropy kinetics.

Data Analysis Modes

- 4-exponential fit with background, shift, reconvolution (based on Marquardt Levenberg algorithm).
- Multi-exponential fluorescence anisotropy fits.



Erythosin B in water, excitation by supercontinuum laser at 520 nm, detection by MCP-PMT at 560 nm. The calculated lifetime is 88±2 ps, with a goodness of fit quality parameter (χ^2) of 1.180.

Specifications

OPTICAL CONFIGURATION	90° between excitation and emission beam path
MODE OF OPERATION	Time Correlated Single Photon Counting Optional Multi Channel Scaling (MCS) Upgrade
LIFETIME RANGE	5 ps – 50 µs (depending on source and detector choice) Up to 1 s with MCS upgrade
MECHANICAL SPECTRAL RANGE	200 nm – 900 nm (standard) 800 nm – 2000 nm (optional for infrared photomultipliers)
SPECTRAL BAND PASS	0 nm – 60 nm (computer controlled)
TEMPORAL DISPERSION	Zero (negligible)
LASER BEAM ATTENUATION	4 order of magnitude, continuously adjustable (computer controlled)
SPECTROMETER SOFTWARE	F980 for Windows® complete software package for data acquisition and lifetime data analysis

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