EDINBURGH INSTRUMENTS

FLS1000

Photoluminescence Spectrometer

Techniques & Configurations

edinst.com

Core FLS1000 Functionality

Spectral Coverage

The FLS1000 Photoluminescence Spectrometer offers exceptional sensitivity (>35,000:1) as a modular single-photon counting spectrometer. The core instrument can measure photoluminescence excitation/emission spectra and kinetics in the UV-Visible range.

Single or Double Monochromators

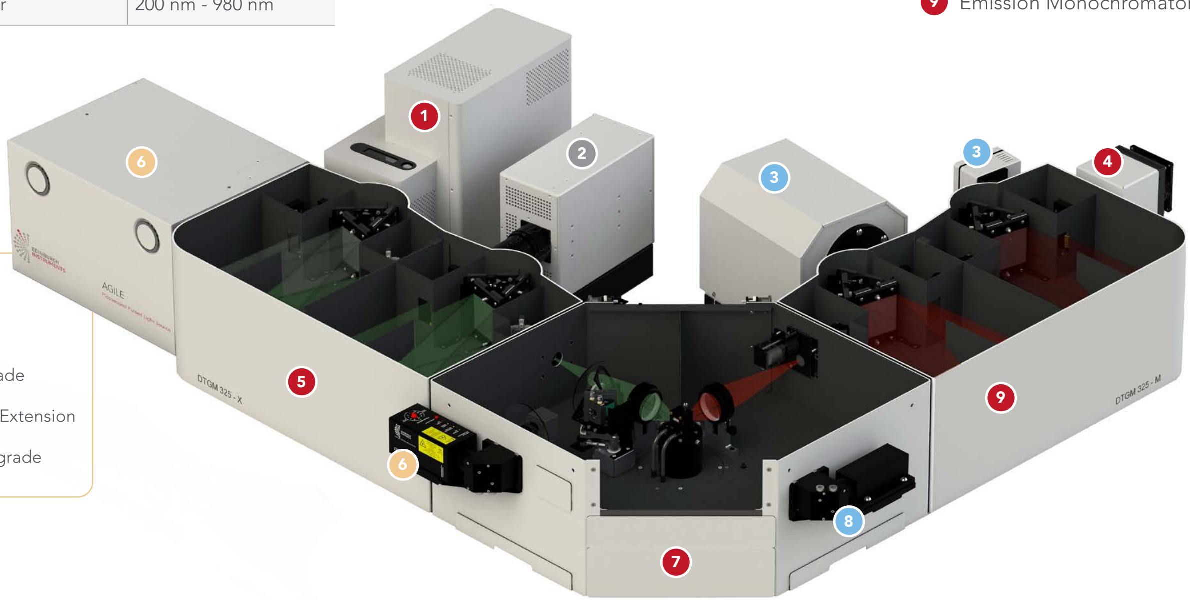
Stray light can interfere with photoluminescence (PL) spectra, especially with reflective solids and powders. The FLS1000's single monochromators reject stray light at a ratio of 1:10^5. For samples with significant scattering, double monochromators (excitation or emission paths) provide superior rejection of 1:10^{10}.

Core Sources and Detectors	Spectral Coverage
Xe lamp Source, ozone free	230 nm - >1000 nm
Xe lamp Source, ozone	<200 nm - >1000 nm
PMT-900 Detector	200 nm - 870 nm
PMT-980 Detector	200 nm - 980 nm

1. Steady State Xenon Arc Lamp
2. μs Flashlamp
3. Optional Alternative Detectors
4. Standard Detector
5. Excitation Monochromator
6. Pulsed Lasers/LEDs
7. Sample Chamber
8. CW Laser
9. Emission Monochromator

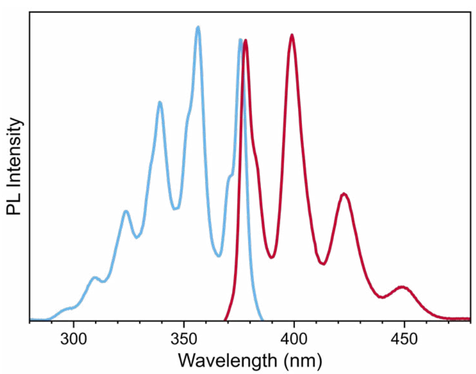
Options Key

- Core
- MCS Upgrade
- NIR & MIR Extension
- TCSPC Upgrade



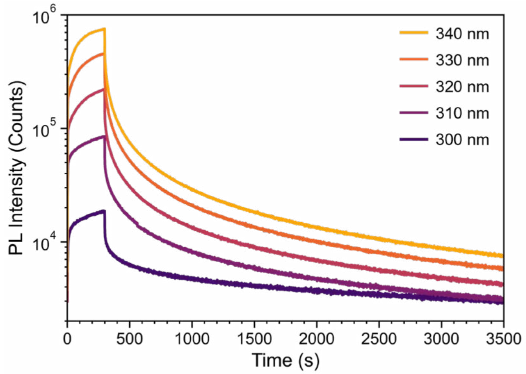
Core Measurement Techniques

Excitation & Emission PL Spectra



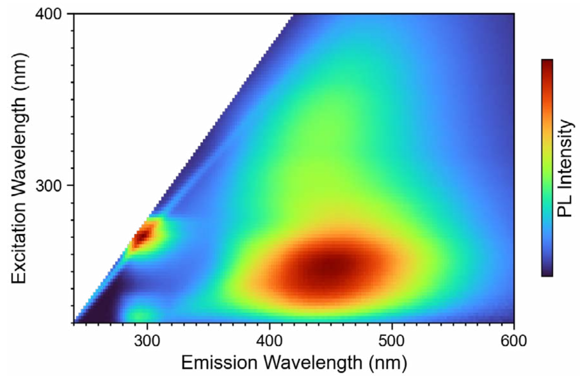
Excitation and emission spectra of anthracene in cyclohexane.

PL Kinetics



Kinetic PL of a persistent luminescence phosphor at different emission wavelengths.

Excitation Emission Maps



EEM of river water with distinct fingerprint of excitation/emission bands corresponding to different types of dissolved organic matter.

TCSPC – Fluorescence Lifetimes

Fluorescence lifetime measures the time a sample spends in an excited state after light absorption. This reveals information about excited state dynamics, energy transfer, and charge carrier dynamics.

Time-Correlated Single Photon Counting (TCSPC) measures these lifetimes with high precision, from picoseconds to nanoseconds.

Edinburgh Instruments TCSPC Sources	
EPL Series	Picosecond Diode Lasers (375 nm - 980 nm)
EPLED Series	Pulsed UV/Green LEDs (250 nm - 610 nm)
HPL Series	High Power Picosecond Diode Lasers (405 nm - 800 nm)
AGILE Supercontinuum Laser	Tuneable Wavelength Laser <400 nm - >2000 nm

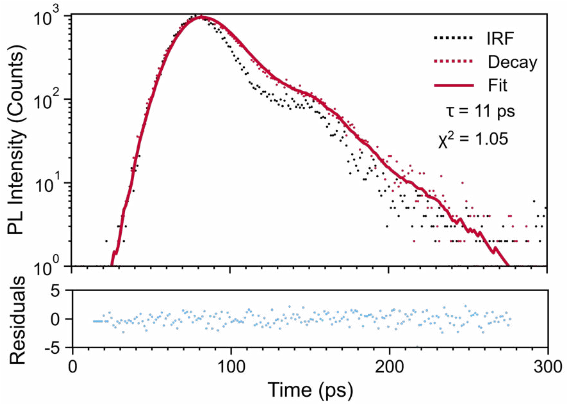
Response Width of TCSPC Source and Detector Combinations

Lifetimes as short as 1/10th of the instrument response width can be measured using TCSPC. For picosecond lifetimes, we recommend adding a High-Speed PMT (HS-PMT) or High-Speed Hybrid Photodetector (HS-HPD).

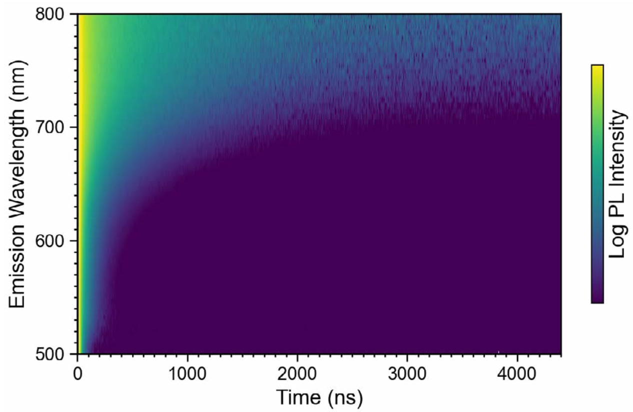
		Source Pulse Widths				
		EPL[a]	HPL[a]	EPLED[a]	AGILE[b]	fs Laser
Detector Response Widths		75 ps	90 ps	900 ps	250 ps	150 fs
PMT-900/980	600 ps	610 ps	610 ps	1080 ps	650 ps	600 ps
PMT-1400/1700-LN2	800 ps	800 ps	810 ps	1200 ps	840 ps	800 ps
PMT-1400/1700-TE	400 ps	410 ps	410 ps	990 ps	470 ps	400 ps
HS-PMT-850/920	200 ps	220 ps	220 ps	920 ps	320 ps	200 ps
HS-HPD-870	20 ps	80 ps	90 ps	900 ps	250 ps	30 ps

a. Typical value, the pulse width depends on the wavelength model of the source.
b. Typical value, the pulse width is wavelength dependent and varies between 200 ps - 350 ps.

AGILE Supercontinuum is a tuneable wavelength laser TCSPC source (<400 nm to > 2000 nm) for ultimate excitation wavelength flexibility.



Picosecond lifetime measurement of 4-DASPI using the HS-HPD lifetime detector.



Time-resolved emission spectrum (TRES) of InP/ZnS quantum dots showing wavelength-dependent lifetime due to trap states.

MCS – Phosphorescence Lifetimes

Phosphorescence lifetime measurements enable the study of triplet states in organic dyes and rare-earth phosphor transitions. These lifetimes are significantly longer than fluorescence lifetimes. Many photoluminescent semiconducting materials, such as quantum dots, also exhibit lifetimes in this range.

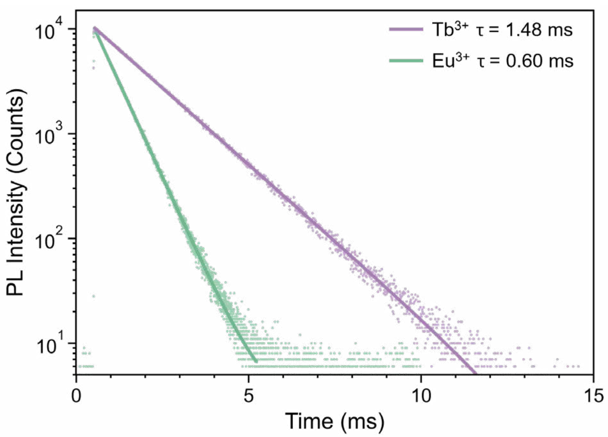
Multichannel Scaling Photon Counting (MCS) measures longer lifetimes, from hundreds of nanoseconds to seconds. While lower time-resolution than TCSPC, MCS acquisition is much faster, making it perfect for phosphorescence.

Edinburgh Instruments MCS Sources

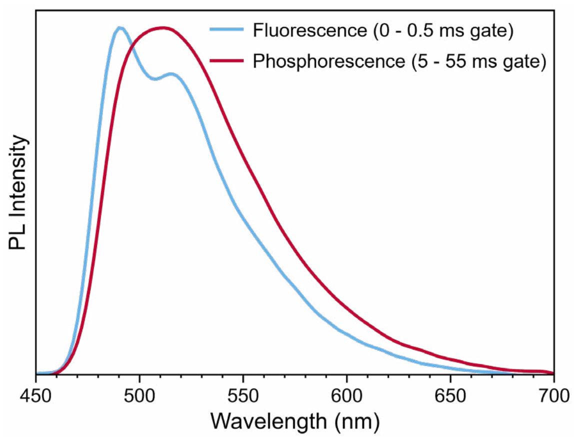
The µs Xe Flashlamp and VPL/VPLED series are dedicated MCS sources optimised for long lifetimes from microseconds to seconds. The EPL and HPL can also be used in MCS mode and are better suited for shorter lifetimes, nanoseconds to microseconds.

	Description	Wavelength Coverage	Pulse Energy	Min. Lifetime	Max. Lifetime
EPL Series	Picosecond Diode Lasers	375 nm - 980 nm	Low	20 ns [a]	1 µs [b]
HPL Series	High Power Picosecond Diode Lasers	405 nm - 800 nm	Medium	20 ns [a]	100 µs [b]
VPL Series	Variable Pulse Width Diode Lasers	375 nm - 980 nm	High	50 ns [c]	20 s
VPLED Series	Variable Pulse Width LEDs	255 nm - 1300 nm	Medium	50 ns [c]	20 s
CW Series	High Power Variable Pulse Width Diode Lasers	<320 nm - >980 nm	Very High	1 µs [c]	20 s
µs Xe Flashlamp	Tuneable Wavelength Flashlamp	250 nm - 1000 nm (Tuneable)	Medium	5 µs [c]	20 s

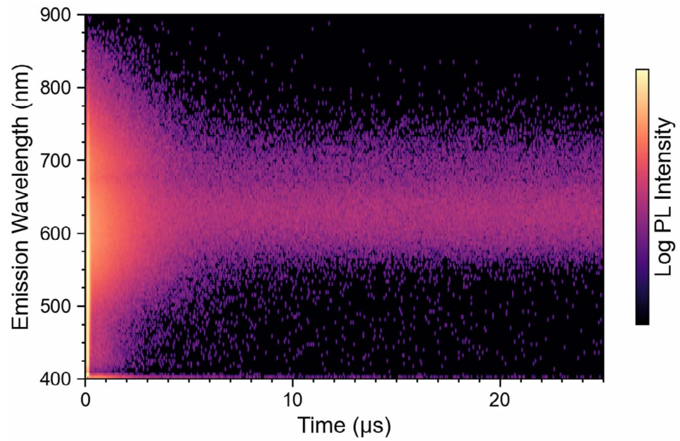
a. Recommended minimum lifetime due to the 10 ns MCS resolution; lifetime measurements below this value are possible.
b. Recommended maximum lifetime which depends on the pulse energy of the source and sample brightness.
c. Recommended minimum lifetime due to the pulse width of the excitation source



Decays of Eu^{3+} and Tb^{3+} with a µs Xe Flashlamp excitation source. The tuneable wavelength of the µs Xe flashlamp is ideal for exciting narrow lanthanide absorption bands.



Fluorescence and Phosphoresce Spectra measured with a gated PMT. MCS can be combined with a gated PMT to separate overlapping fluorescence and phosphorescence spectra.



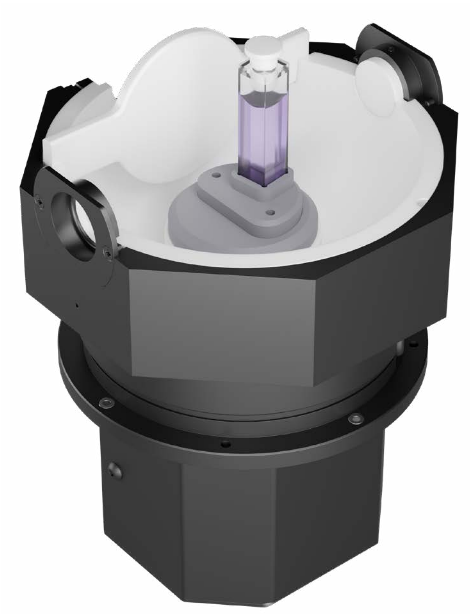
Time-resolved phosphorescence spectrum of Mn^{2+} ions in SbMnCl showing energy transfer from Sb centers to Mn centers.

Quantum Yield

Photoluminescence quantum yield measures the ratio of photons absorbed to photons emitted, quantifying a sample's effectiveness as a light emitter. Accurate quantum yield measurements are essential for many applications, including developing new fluorescence probes and creating next-generation light-emitting diodes.

Our QYPro Integrating Sphere enables rapid and accurate quantum yield measurements of solids and liquids across the UV, Visible and NIR. The QYPro features a revolutionary motorised sample-loading mechanism to prevent contamination.

QYPro™ Integrating Sphere



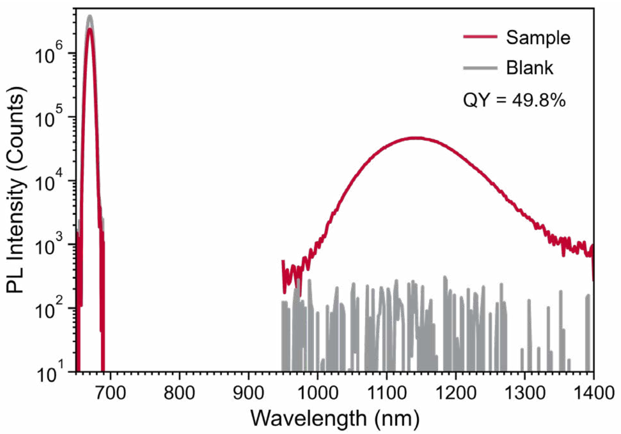
Cuvette Holder

Solid and Powder Holder

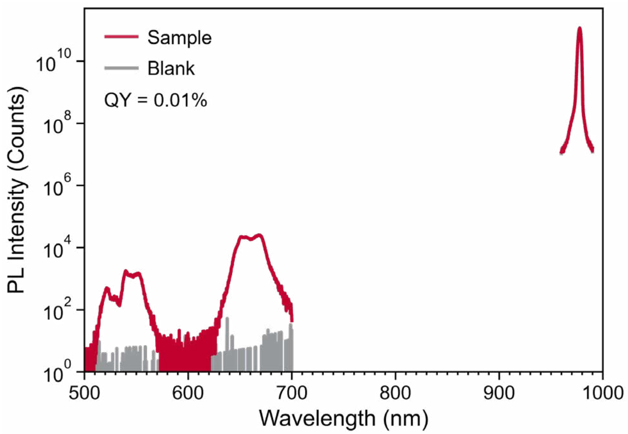
EL Holder

Sphere Material	Optical Grade Sintered PTFE
Sphere Inner Diameter	125 mm
Wavelength Range	250 nm - 2500 nm
Sample Type	liquids, films, powders
Contamination Prevention	automated sample loading mechanism
Gas Purging	purge ports for Ar or N_2 purging
Liquid Sample Holder	1 cm pathlength quartz cuvette
Powder Sample Holder	ø13 x 2 mm solid PTFE tray with quartz cover*
Film Sample Holder	Sintered PTFE plug for samples up to 17 x 17 mm or ø 20 mm*
Upconversion	with PMT-1010 or PMT-NIR-LN$_2$ detectors
Electroluminescence	optional EL Holder for EL spectra

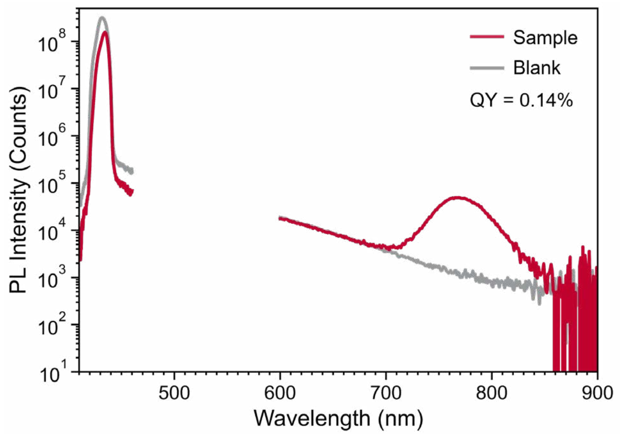
*Other sizes are available



NIR Quantum Yield of PbS quantum dots measured with the PMT-NIR-1700-LN$_2$ photodetector.



Upconversion Quantum Yield of NaYF4:Yb,Er nanoparticles measured with a 2W CW-980 laser and PMT-1010 photodetector.



Semiconductor Quantum Yield of perovskite solar cell, demonstrating that the QYPro is capable of measuring the low QY semiconductors.

NIR Extension

Near Infrared (NIR) luminescence, spanning wavelengths from 750 nm to 2500 nm is critical for many applications. These applications include studying low-bandgap semiconductors, using novel fluorescent probes for biological imaging and investigating singlet oxygen generation for photodynamic therapy.

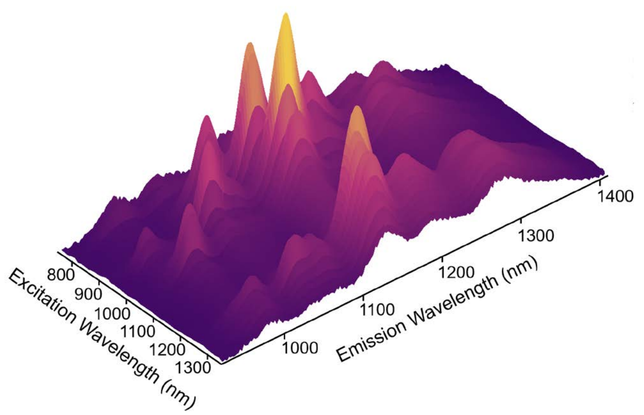
Standard photodetectors cover wavelengths up to 950 nm (PMT-980). For studying luminescence beyond 950 nm, an additional NIR photodetector is required.

Edinburgh Instruments NIR Photodetectors

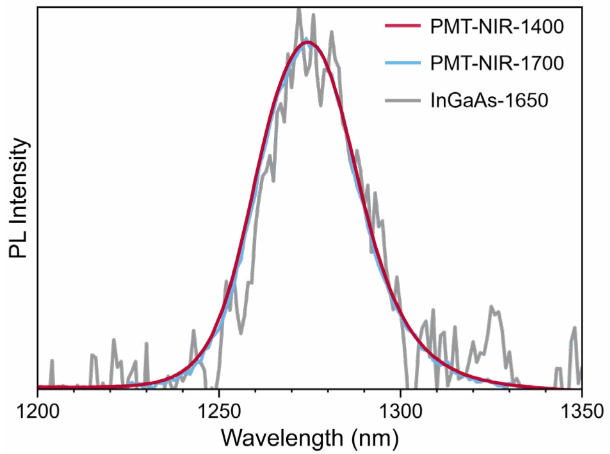
Analogue InGaAs detectors are lower cost and ideal for measuring the NIR spectra of high-quantum-yield materials, such as quantum dots. Photon-counting NIR-PMTs are more sensitive, enabling the measurement of less emissive samples.

	Type	Wavelength Coverage	Minimum Lifetime	Relative Sensitivity
PMT-NIR-1400-TE	Photon Counting	930 nm - 1390 nm	150 ps [a]	Highest
PMT-NIR-1700-TE	Photon Counting	930 nm - 1655 nm	150 ps [a]	High
PMT-NIR-1400-LN2	Photon Counting	500 nm - 1390 nm	270 ps [a]	Highest
PMT-NIR-1700-LN2	Photon Counting	500 nm - 1655 nm	270 ps [a]	High
InGaAs-1650-TE	Analogue	870 nm - 1650 nm	50 ns (ns laser)[b] / 1 μs (μs laser)[c]	Medium
InGaAs-2050-TE	Analogue	900 nm - 2050 nm	50 ns (ns laser)[b] / 1 μs (μs laser)[c]	Medium
InGaAs-2550-TE	Analogue	900 nm - 2550 nm	50 ns (ns laser)[b] / 1 μs (μs laser)[c]	Low

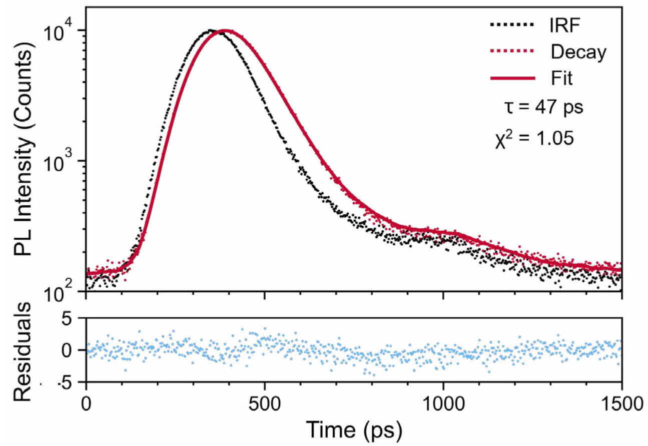
a. Minimum lifetime is defined as 1/3rd of the response width using an EPL/HPL as the excitation source.
b. Minimum lifetime with a high pulse energy nanosecond pulsewidth Nd:YAG or OPO excitation source.
c. Minimum lifetime with CW series diode laser, usually a CW808 or CW980.



NIR EEM of single-wall carbon nanotubes acquired with an InGaAs NIR camera. NIR InGaAs cameras can be added when rapid NIR EEMs are required.



Singlet oxygen phosphorescence spectra acquired with analogue and photon-counting photodetectors showing the difference in SNR between photon-counting and analogue detection.



IR1061 fluorescence decay acquired with a high-speed NIR SPAD photodetector.

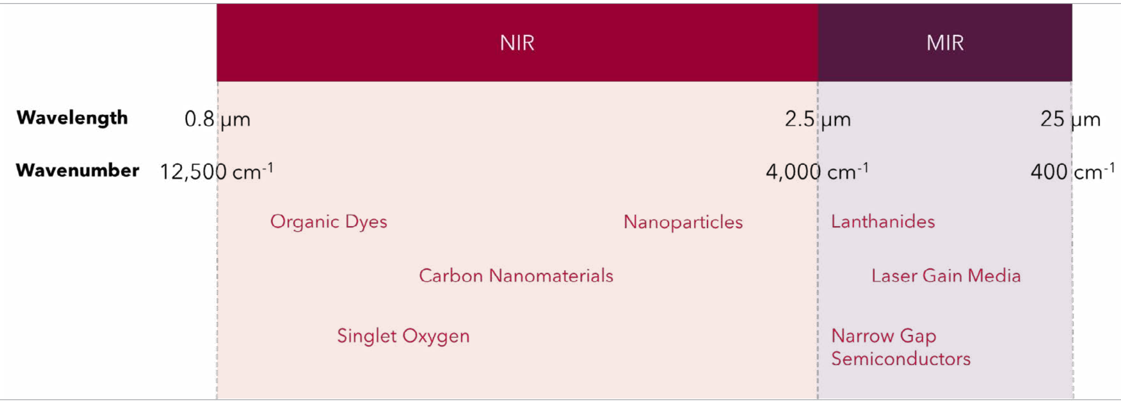
MIR Extension

To achieve the best sensitivity, the detectors are liquid nitrogen cooled, and the signal is lock-in amplified to reduce noise when acquiring spectra. We eliminate thermal blackbody radiation at ~3.5 μm, a common issue in MIR spectroscopy, with the combination of two choppers and a phase shift controller.

We recommend excitation with a high-power laser to maximise the MIR PL signal. For lanthanides, we suggest CW808 or CW980 lasers (~1 W). You can pulse them with a Pulse Modulator control box giving pulse widths from < 3 μs. Time-resolved PL of samples with sub-μs lifetime requires a Nd:YAG laser or OPO with pulse widths in the nanosecond range.

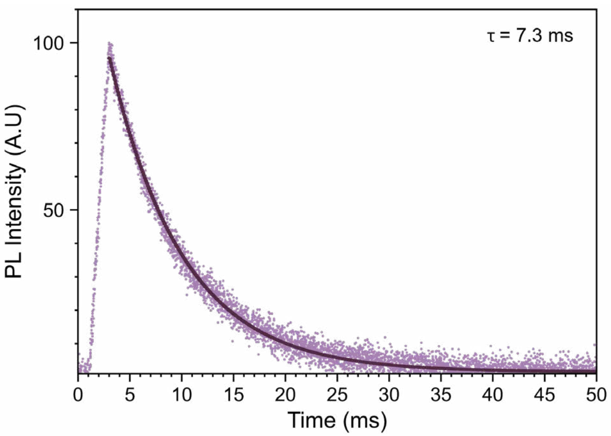
Edinburgh Instruments MIR Photodetectors

Analogue InAs and InSb detectors allow you to measure PL in the Mid Infrared (MIR) range.

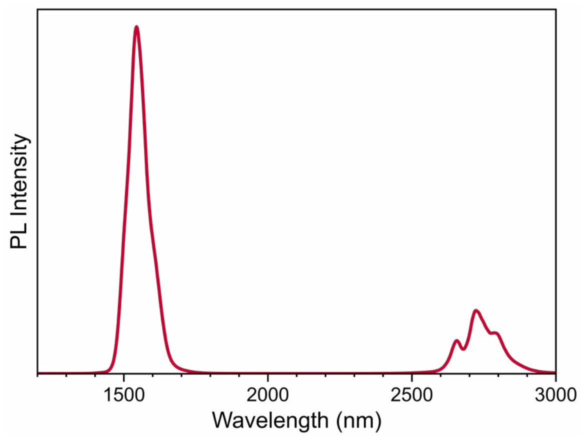


	Type	Wavelength Coverage[a]	Minimum Lifetime[b]
InAs-3500-LN2	Analogue	1.2 μm - 3.1 μm	50 ns (ns laser) / 1 μs (μs laser)
InSb-5500-LN2	Analogue	1.5 μm - 5.5 μm	50 ns (ns laser) / 1 μs (μs laser)

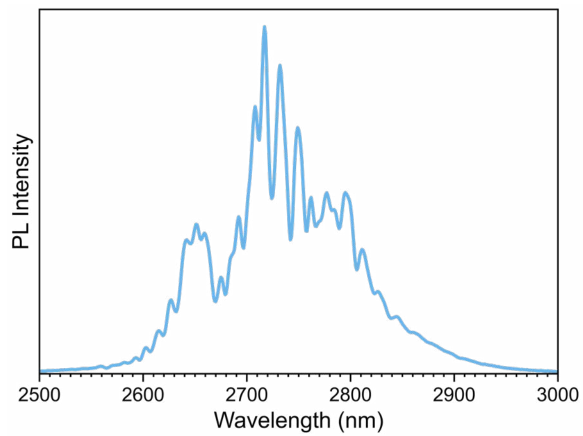
a. Wavelength range may vary depending on emission gratings.
b. Enabled with lifetime or dual versions of the detector. Recommend limit, measurements below this value are possible.



MIR PL decay of an Er^{3+}-doped glass detected at 2.75 μm with an InAs detector. Excitation with a CW980 laser at 1 ms pulse width.



Emission spectrum of Er^{3+} glass, excitation with a CW980 laser and detection with an InAs detector.



High-resolution emission spectrum of the $^4I_{11/2}$ --> $^4I_{13/2}$ transition in Er^{3+}, excitation with a CW980 laser and detection with an InAs detector.

Temperature Control

Studying the temperature dependence of photoluminescence spectra and lifetimes reveals an extra dimension of information. Examples include measuring low temperature phosphorescence spectra, studying the dependence of energy transfer rates and optimising temperature sensing probes.

You can configure the FLS1000 with a range of temperature-controlled cuvette holders, cryostats, and Dewars for temperature studies between 2 K and 870 K. The holders are software-controlled, so you can automatically acquire temperature maps of spectra or lifetime.

Thermoelectrically (TE) Cooled Cuvette Holders

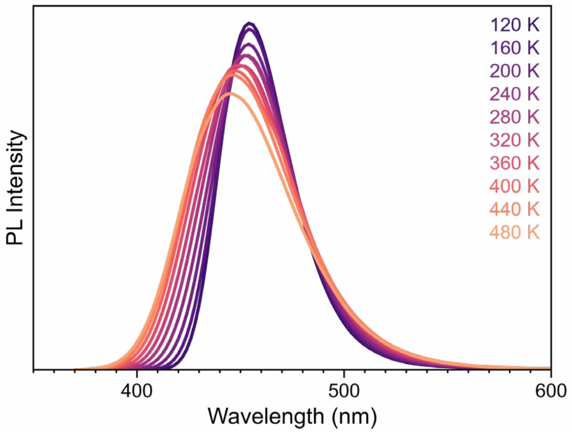
Temperature-controlled cuvette holders are available for temperatures between -50 ˚C and +150 ˚C. A TE cooled 4-position cuvette holder for automated sample exchange is available for repeated measurements on multiple cuvettes.

Cryogenic Sample Holders

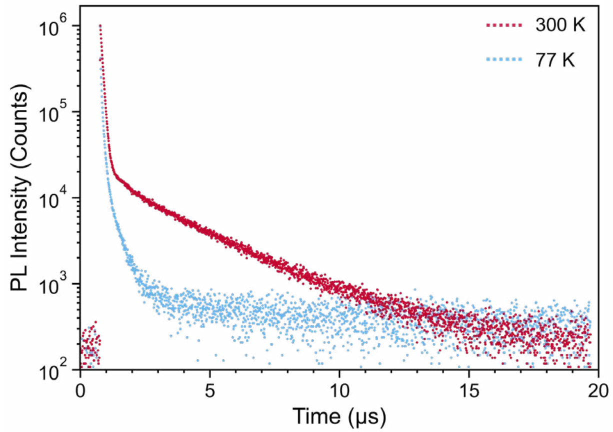
Liquid nitrogen and liquid helium cryostats allow automated temperature-dependent measurements of liquids, solids, and powders down to cryogenic temperatures. Liquid nitrogen options are suitable for 77 K – 500 K whereas liquid helium cryostats are available with ranges between 2 K and 800 K. For measurements at room temperature and 77 K only, choose a sample Dewar compatible with liquids and powders.

Sample Holder Type	Sample Compatibility	Temperature Range[1]	Notes
Liquid N_2 Cryostat [2,3]	Cuvettes, solids, powders	77 K - 500 K	Liquid N_2 reservoir in cryostat
Liquid He Cryostat [2,3]	Cuvettes, solids, powders	2.3 K - 500 K	Requires pressurised He storage vessel
He Closed Cycle Cryostat [2,3]	Cuvettes, solids	2.3 K - 800 K	Liquid He-free operation
Microscopy Cryostats [3]	Solids, powders	3.2 K - 873 K	Coupled to FLS1000 via fibres Compatible with microscopes
Dewar	Liquids, Powders	77 K or room temperature	

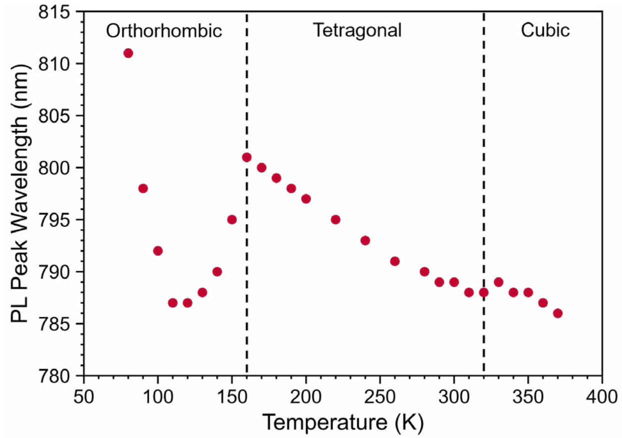
1. Model dependent
2. Options for sample in exchange gas enabling fast exchange of samples
3. Options for sample in vacuum reducing sample surface contamination



Temperature map of PL emission spectrum of a phosphor in a liquid N_2 cryostat, excited at 255 nm.



PL decay of a TADF material acquired at room temperature and 77 K. The long component is suppressed indicating that it is TADF rather than phosphorescence.



Phase transitions of a halide perovskite followed by a shift in the PL peak wavelength measured in a liquid N_2 cryostat.

Automation

Multi-Position Sample Holders

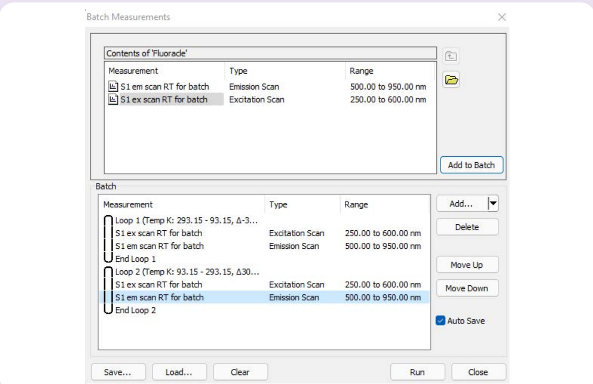
Quickly measure multiple samples under identical conditions with automated cuvette holders, saving valuable lab time.

Microplate Reader Accessory

Process up to 384 samples efficiently with a microplate reader. You can make with spectral or time-resolved measurements, and create and store custom plate layouts.

Batch Measurement Mode

Automate complex measurement sequences with batch mode. Easily program loops, delays, sample exchanges, and temperature variations. Commands to third-party accessories can be sent via USB for endless customisation possibilities.



Batch wizard in Fluoracle. Batch sequences can be saved and loaded. Data acquired during the batch can be saved automatically.

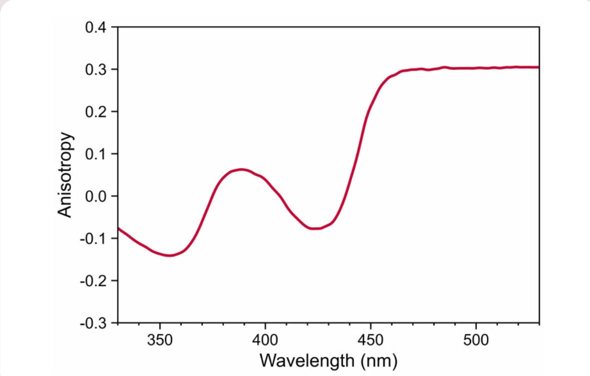
Polarisation

Fluorescence Anisotropy

Fluorescence anisotropy occurs when the intensity of fluorescence varies depending on the axis of polarisation. You can measure spectral and time-resolved anisotropy with software-controlled polarisers. These experiments can help you understand molecular orientation, binding, energy transfer, and local viscosity; in particular for large molecules and viscous solutions.

Circularly Polarised Luminescence (CPL)

CPL spectroscopy analyzes samples that preferentially emit circularly polarised light of a specific chirality. This is useful for studying chiral molecules like proteins and drug enantiomers. Applications include displays, data storage, and security.



Excitation anisotropy spectrum of rhodamine B in glycerol using polarisers. The bands observed correspond to electronic transitions with varying fundamental anisotropy.

Upconversion

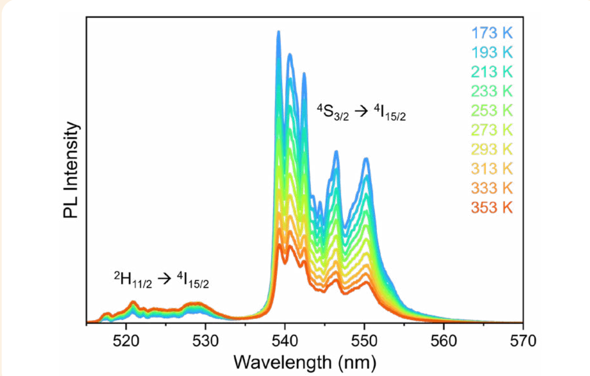
Upconversion Spectra

Photon upconversion converts multiple absorbed photons into a single higher-energy emitted photon. This phenomenon has potential applications in bioimaging, solar cells, and photonics.

Inorganic upconverters typically require a continuous wave (CW) laser at 980 nm or 808 nm to characterise their upconversion luminescence. Molecular triplet-triplet annihilation upconverters may require a high-power visible CW laser.

Time-Resolved Upconversion

The dynamics of upconversion can be studied with a time-resolved measurement, usually in MCS mode. This is achieved with high-power pulsed lasers of tunable pulse width.



Upconversion thermometry with a lanthanide-doped material. The ratio of intensities between the two transitions can be used to probe the temperature of a sample.

Microspectroscopy

Widefield Imaging & Spectroscopy

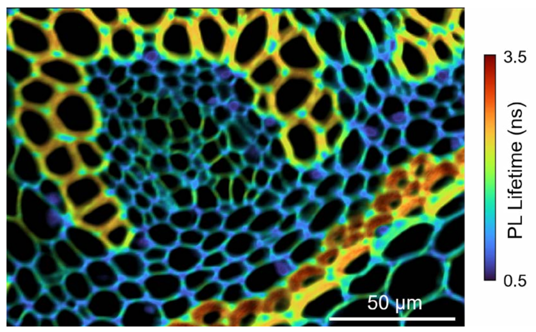
Capture fluorescence images using the spectrometer lamp as a tunable excitation source. This offers more flexibility than traditional filter-based microscopes.

Micro-Spectroscopy & Lifetime Imaging

Utilise either the spectrometer lamp or a laser for excitation. The lamp provides spectra for the entire field of view, while the laser enables micrometer-precision point spectra and lifetimes (TCSPC or MCS).

FLIM/PLIM

Add a software-controlled XYZ stage for Fluorescence/ Phosphorescence Lifetime Imaging Microscopy (FLIM/ PLIM), which maps the variation in PL lifetime across the sample in 2D, surface and 3D modes.



FLIM image of a stained convallaria root acquired with the MicroPL upgrade.

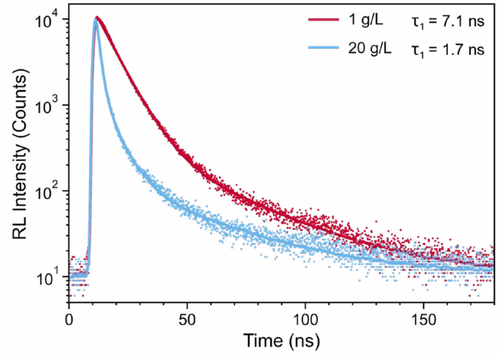
Radioluminescence

X-ray Radioluminescence

You can study scintillators that emit UV, visible or NIR radiation with the XS1 accessory. The XS1 is a sample chamber housing one or two x-ray sources and connected to the spectrometer for detection. Samples can be liquids, solid slides, and powders. Such versatility makes it compatible with almost every type of scintillator, from perovskite solutions to inorganic crystals.

CW and Pulsed X-ray Excitation

The XS1 can be configured with CW and pulsed x-ray sources. You can acquire time-resolved radioluminescence experiments using TCSPC or MCS, depending on the lifetime of the sample. The x-ray pulse has a minimum width of ~100 ps if the source is triggered with a HPL laser. MCS decays benefit from a VPL source providing wider pulses.



Radioluminescence decays of LAB/PPO scintillator at different concentrations of PPO, acquired using the XS1 accessory in TCSPC mode.

Electroluminescence

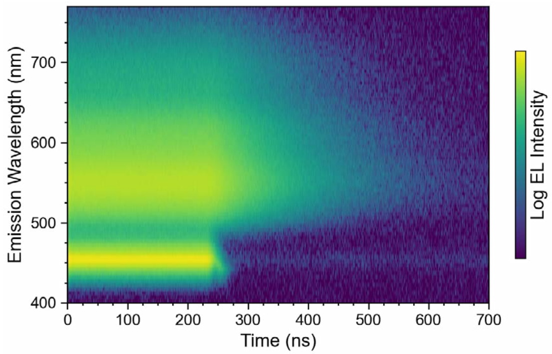
Electroluminescence (EL) Spectroscopy

Characterise light-emitting devices with EL spectroscopy. This technique excites the sample electrically rather than optically.

Source units and sample holders are available for both spectral and time-resolved EL. For geometry-independent spectra, use the QYPro integrating sphere.

Time-Resolved EL

Combine a pulsed voltage source with TCSPC or MCS electronics to measure EL lifetimes. This technique is invaluable for understanding the EL mechanism and has broad applications, such as studying charge carrier dynamics in semiconductors and solar cells.

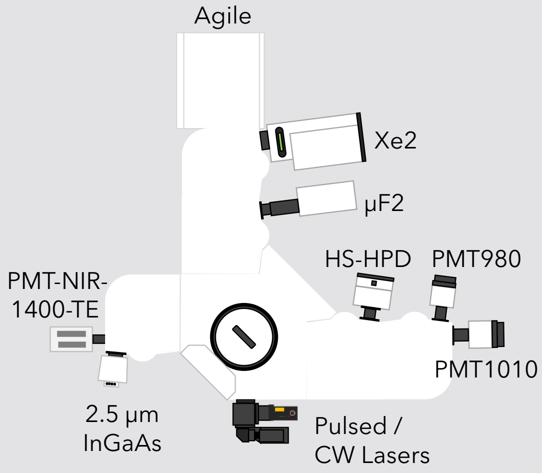


Time-resolved electroluminescence spectrum from a white LED acquired with a pulsed voltage source in TCSPC mode.

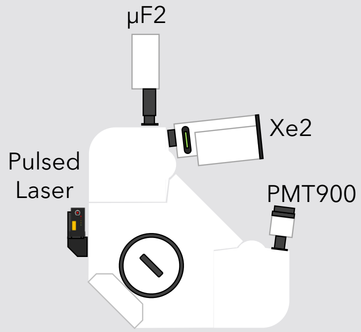
FLS1000 Configurations

With thousands of configurations available, you can fine tune the FLS1000 to your exact requirements. These are just a few examples.

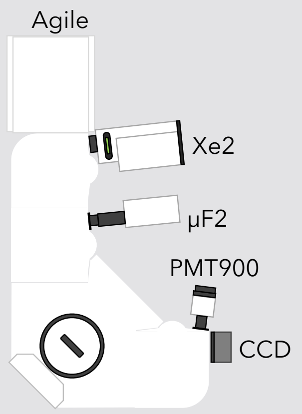
FLS1000-DDS for steady state, MCS and TCSPC, upconversion, fast fluorescence lifetimes, and NIR emitting samples



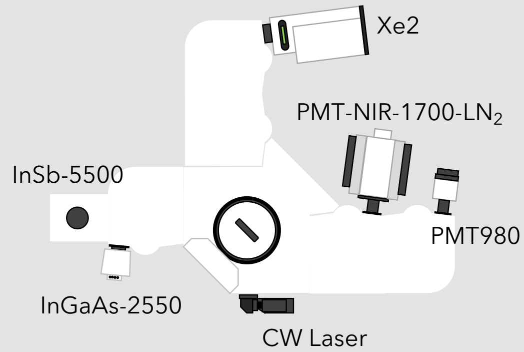
FLS1000-SS for steady state, MCS and TCSPC



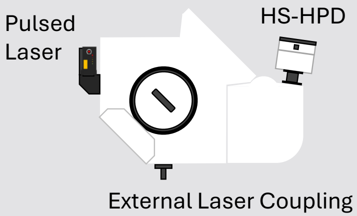
FLS1000-DS for steady state, MCS and TCSPC, tunable TCSPC source, and fast spectral acquisition with CCD



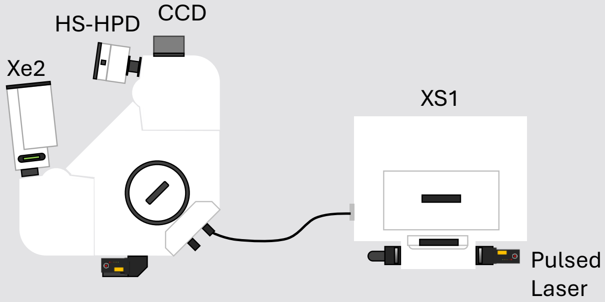
FLS1000-DDS for steady state, laser excitation, NIR and MIR emitting samples



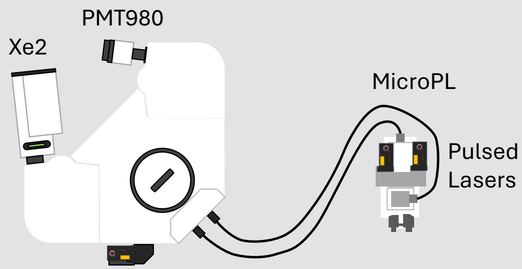
FLS1000-xS for TCSPC with fast detector and two pulsed sources



FLS1000-SS for steady state, MCS and TCSPC radioluminescence with the XS1 accessory



FLS1000-SS for steady state, MCS and TCSPC on a microscope



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