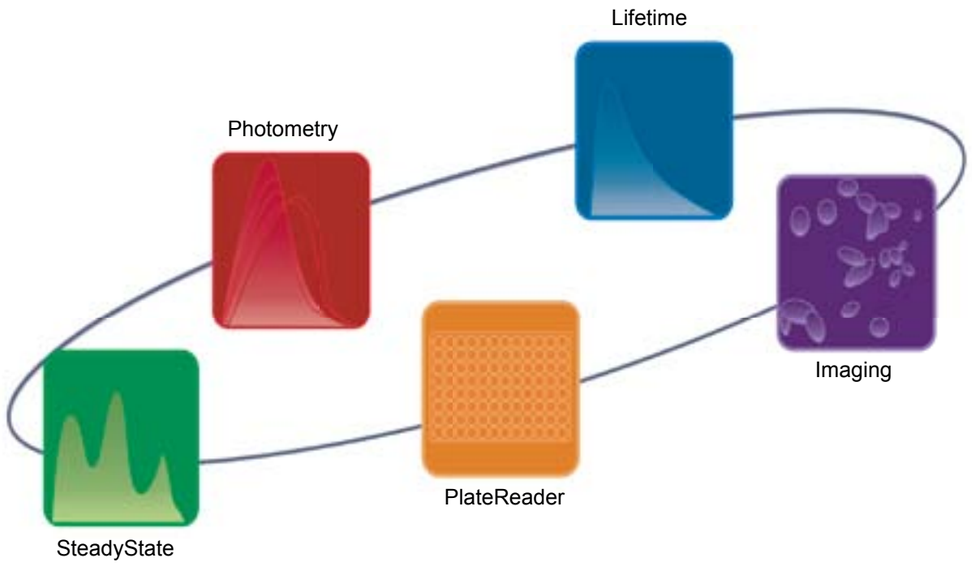
QuantaMaster

Fluorescence - Luminescence
UV VIS - NIR

Approach

The only constant in fluorescence applications is the phenomenon of fluorescence itself. The numerous ways that fluorescence is used in research today demands that the fluorescence instrument adapt to changing spectroscopic requirements, unique sample considerations, and new data analysis procedures. Therefore, the ideal instrument for fluorescence spectroscopy must be multidimensional. Photon Technology International, Inc. is able to provide the highest quality and most flexible spectrofluorometers worldwide by concentrating all of its efforts in research and customer support on fluorescence. PTI is the oldest independent fluorescence company, specializing in manufacturing and selling complete spectroscopy systems as well as their basic building blocks for over twenty years. For this reason, PTI is the Fluorescence Solution Company. You can obtain a luminescence spectrophotometer from a company that supplies a wide range of scientific items from chromatography to basic labware, or you can come to PTI - from our sales engineers to our software engineers we are the experts in fluorescence.

The Fluorescence Solution Company



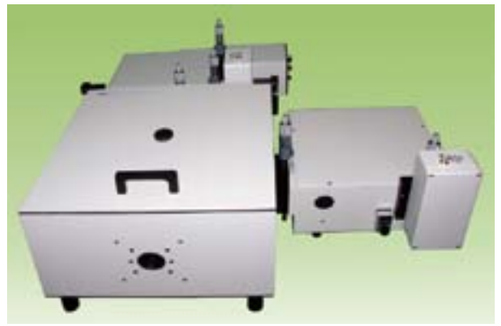
Steady State – Continuous Excitation

Ultimate in Sensitivity

The QuantaMaster™ series of research grade spectrofluorometers are versatile systems for steady state fluorescence measurements. The foundation of a fluorescence spectroscopy laboratory is built on steady state intensity measurements such as wavelength scans, time-based experiments, and synchronous scans. All of these acquisitions are easily handled by the QuantaMaster™ series while boasting the highest sensitivity in the industry. The highest sensitivity allows for the most minute traces of fluorescent materials to be detected and identified in mixtures. Oil samples can be fingerprinted and identified. Distances within macromolecules can be easily measured. The dynamics of protein folding can be studied. Concentrations of ions can be measured inside living cells. Membrane structure and function may be studied with fluorescence probes. These are just some of the examples of the many applications that the QuantaMaster™ system can handle.

In addition, the QuantaMaster™ series modular design offers reassurance that your system can be easily customized and adapted to your growing research capabilities.

Phosphorescence – Pulsed Excitation



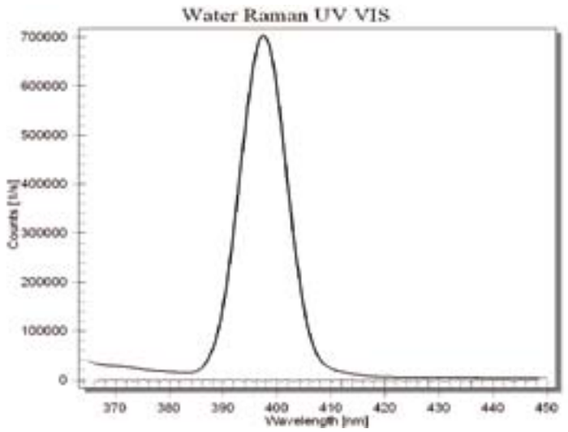
Prevent Photobleaching
Ideal for Luminescence/Phosphorescence

The QuantaMaster™ can be equipped with a pulsed light source. The continuously tunable repetition rate (up to 300Hz) of the Xe lamp is of great benefit to users who utilize fluorescent probes that are prone to photobleaching. With the pulsed Xe lamp, the sample is exposed to light for only 0.03% of the duration of the experiment. Therefore, this configuration is ideal for all photosensitive kinetic assays such as GFP and many biological samples. The pulsed Xe lamp combined with a gated detector is also used for the determination of phosphorescence spectra and phosphorescence lifetimes. This is achieved by introducing a user selectable detection time window in the data acquisition software. When the window is fixed and placed away from the excitation pulse, a phosphorescence spectrum can be measured. Alternatively, the window can be swept in time yielding a phosphorescence decay curve. The pulsed Xe source and the gated detector are especially advantageous for all lanthanide-based probes. The long lifetimes of these probes make it possible to place the detection window far enough away from the excitation pulse, thus completely removing organic fluorescence and scattered light contamination from the signal. It is an ideal system for measuring long-lived photoluminescence of lanthanide-based probes.

Sensitivity

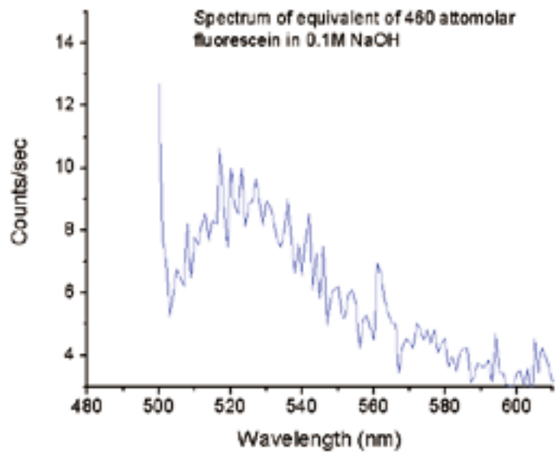
The industry standard for sensitivity is a signal to noise ratio for a measurement of a water Raman spectrum. Yet, what does that actually mean in terms of a real world application? The truth is that there is no standardized experiment to measure water Raman. While we at PTI demonstrate the industry standard water Raman test to illustrate signal to noise ratio, we also show the true detection limit of our system using the fluorescein fluorophore – the lowest detection available in today's market.

Signal to Noise Ratio of a QuantaMaster™ 4 CW



Water Raman spectrum measured with a regular, production grade steady state QuantaMaster™ system. Minimum specification for the QuantaMaster™ series is 10,000:1 signal to noise. However this is the minimum specification and often our systems are able to achieve much higher S/N values, as illustrated here by the Raman signal resulting in S/N = 16,000:1. Experimental conditions: λex = 350 nm, spectral bandwidth (ex, em) = 5 nm, integration time = 1 s.

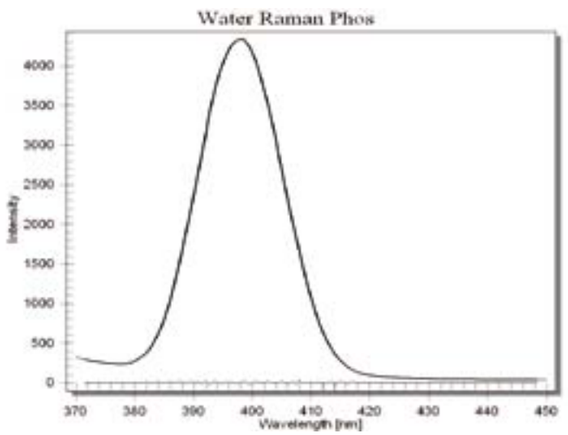
Attomolar sensitivity of the QuantaMaster™ 4 CW. A true sensitivity test utilizing a real fluorophore – unsurpassed performance of the QuantaMaster™ equipped with a continuous 75 W Xe light source and a photon counting PMT detector.



Why Sensitivity Of An Instrument Is The Most Important Parameter

Sensitivity is important to you because the sensitivity of an instrument determines the accuracy of measurements at low concentrations. High sensitivity accrues better accuracy at low concentrations. By using lower concentration samples, you will save valuable resources such as money and time.

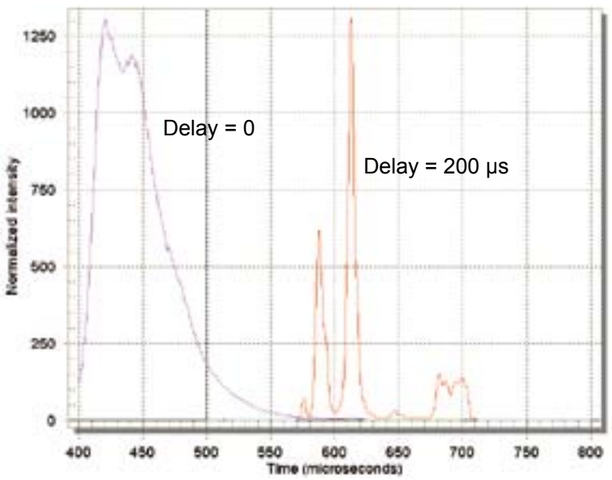
Signal to Noise Ratio of a QuantaMaster™ 3 PH



Water Raman spectrum obtained with the QuantaMaster™ 3 PH equipped with a pulsed Xe lamp and gated detector. The minimum specification of a pulsed QuantaMaster™ system is 3,000:1. Often a much higher S/N is attainable. This S/N represents the highest sensitivity on the market for this type of instrument.

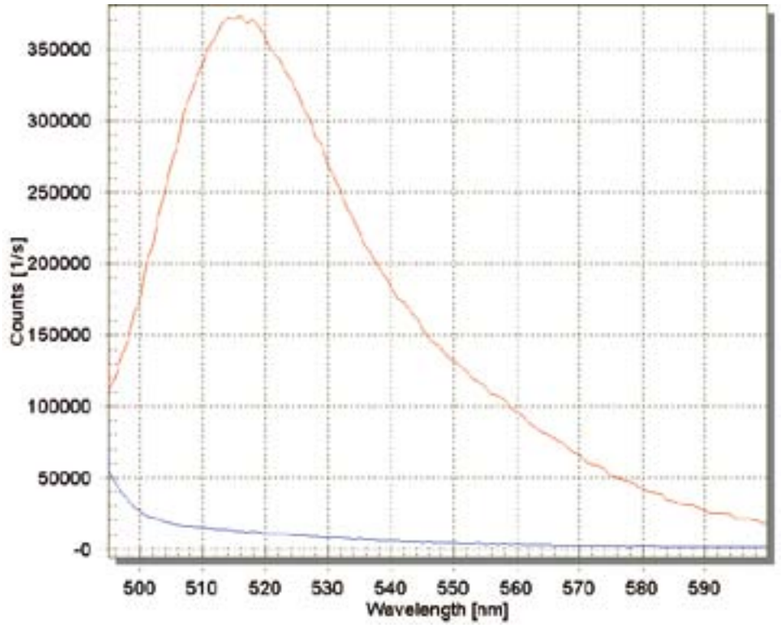
Chelated Europium

The QuantaMaster™ 3 PH system equipped with a pulsed lamp and a gated detector is invaluable in boosting the detection sensitivity of otherwise almost undetectable europium emission obscured by fluorescence (trace at delay = 0) from organic ligand. By placing the detection gate 200 microseconds away from the excitation pulse, a clean spectrum of europium ion is observed (trace at delay = 200 µs), while the impurity fluorescence is completely suppressed.



Stray Light

Suppression of stray light is one of the most critical factors when measuring highly scattering or low quantum yield samples. Every QuantaMaster™ series spectrofluorometer is custom made with the highest quality optics to insure the lowest amount of scatter. This allows for the best detection of the true fluorescence signal. The QuantaMaster™ series boasts a high stray light rejection: 10^{-4} in a single excitation monochromator configuration and 10 with double monochromators.



Fluorescence spectrum of highly turbid suspension of fluorescein-labeled beads (red trace) and the background sample (blue trace) excited at 488 nm. Excellent stray light rejection performance (double excitation and single emission monochromators) allows for emission scanning very close to the excitation wavelength.

Signal Detection For Any Application

For most applications, the typical detector employed is a photomultiplier tube (PMT). Every QuantaMaster™ features a highly sensitive PMT, with the option of an analog or digital output. PTI offers you the ability to customize the system to meet your applications needs. Digital detection, or photon counting, offers the highest sensitivity as it records single photon events. The analog detection measures the current that is generated on the PMT anode and provides for additional detection gain ranges. This greatly enhances the dynamic range of the instrument, especially for higher intensity signals.

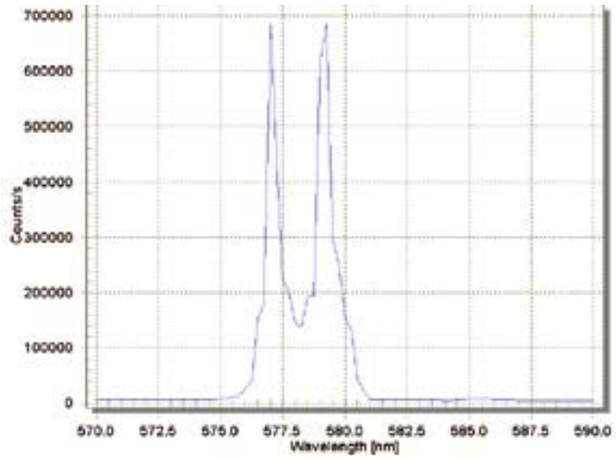
For NIR and IR applications, we also offer specialized PMTs and solid state detectors such as InGaAs diode detectors that are capable of detecting out to 2.2 microns. Gated detectors for luminescence lifetime measurements are also available.

Resolution

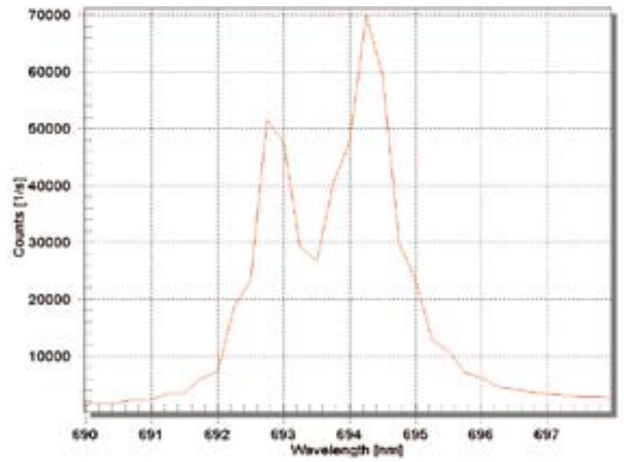
The QuantaMaster™ spectrofluorometers use a precision driven Czerny-Turner monochromator with custom gratings to meet your specific application needs. More than 30 different gratings are available. Due to the combination of the computer-controlled motor with micro-stepping resolution and available grating selection, it is possible to achieve 0.1 nm step size. This means that you can resolve spectral features as close as 0.2 nm apart in the UV and VIS spectral regions.

Hg doublet

Hg doublet measured with the standard 1200 lines/mm grating and bandpass of 0.25 nm.



Ruby Crystal doublet



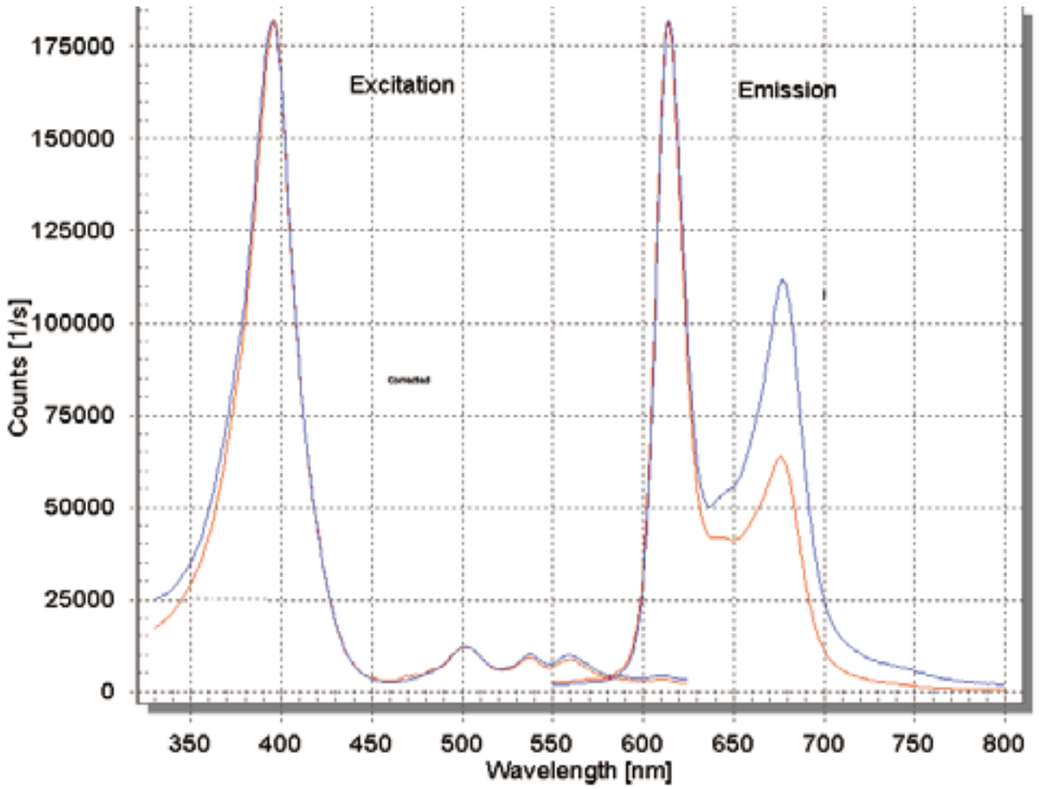
Ruby crystal doublet easily resolved with the QuantaMaster™ system equipped with a double emission monochromator with 1200 lines/mm gratings

Excitation And Emission Correction

PTI offers you peace of mind concerning the many factors in attaining true fluorescence excitation and emission data. All light sources emit light that is not of equal intensity across the output spectrum, and this can lead to errors in the measurement of an excitation spectrum. The raw data must then be corrected for this discrepancy. PTI systems utilize a reference diode detector that has been calibrated and installed at the factory. Excitation correction is performed in real-time. During an experiment, part of the excitation beam is diverted prior to reaching the sample. This fraction of photons is measured and then corrected. The reference detector then provides a corrected output that is independent of the excitation source characteristics or any temporal fluctuation of the lamp intensity, thus ensuring excellent stability of the signal.

A similar phenomenon exists for emission data. Since the detection efficiency of the optics, gratings, mirrors and detector is not equivalent at all wavelengths, some type of correction must be performed to account for these variations. Typically, the emission channel is calibrated at the factory with a known light source such as a NIST-traceable standard. This information is used to construct a correction file, which is then stored locally on your computer. Multiplication of the raw data by this correction file yields the true corrected emission spectrum. This correction can be performed in real-time or can be recalled in later analysis of the raw data and applied in the easy to use FeliX32™ software.

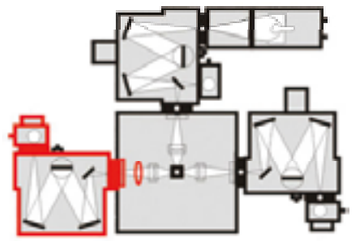
Raw and corrected Hematoporphyrin excitation and emission spectra. Corrected data shown in blue.



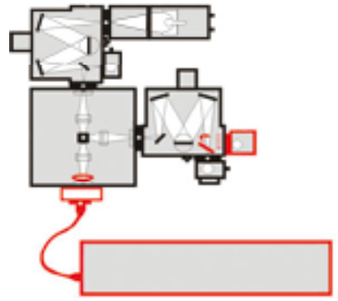
Modularity To Grow With

The QuantaMaster™ series features an open architecture design that provides the ultimate in versatility, allowing your instrument to adapt to your future fluorescence application needs. You can optimize the initial configuration by choosing the light source, gratings, PMT tubes, as well as a wide array of available accessories. The number of available configurations is limitless!

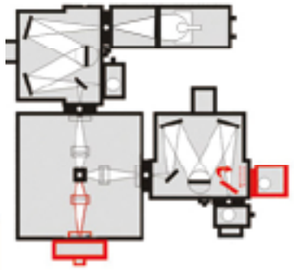
PTI's universal QuadraCentric™ sample compartment has a spacious design that provides accessibility and can accommodate a wide selection of sample accessories. Choose from sample temperature controllers to various holders for solids, liquids, and powders, and many other options. See the Accessories page for more details.



Add a second emission channel

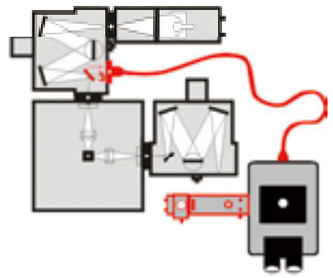


Add lifetime capability with a pulsed nitrogen/dye laser

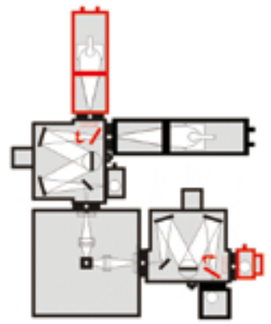


Add lifetime capability with pulsed nano-LEDs

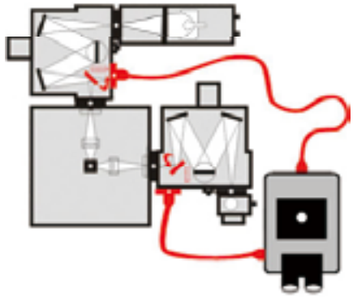
The Open Architecture design also allows for application and methodology changes. As your application needs grow, so can your QuantaMaster™. For example, if you develop a need to measure dynamic anisotropy, you can add a second emission channel and a set of polarizers. If you want to complement your steady state data with lifetime measurements, you can do so by adding a laser or LED-based excitation to your initial configuration. After completing initial Fura-2 studies, you may decide you would like start imaging the events. The system can be easily coupled with any fluorescence microscope. Whether you choose to add NIR detection or a second excitation source, the possible configurations are endless...



Upgrade to fluorescence microscopy with an additional PMT detector equipped with an eyepiece aperture



Add a pulsed light source and a gated detector for phosphorescence or lanthanide emission



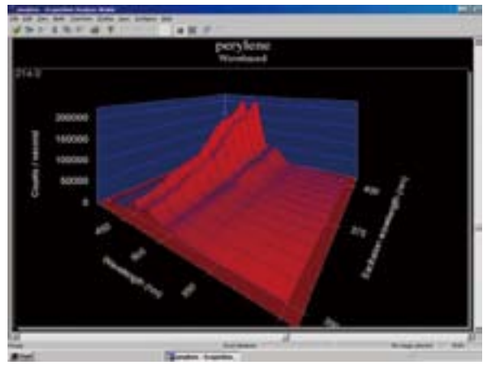
Couple to a microscope and feed back into the existing emission monochromator

Software

PTI's FeliX32™ is the most comprehensive software package on the market. It's easy to use Windows™ based interface offers one software solution for all your fluorescence measurements. FeliX32™ uses full 32-bit implementation graphic capabilities, including sophisticated 3-dimensional plotting and full motion rotation. All major data handling packages are included: multi-exponential fits, global analysis, non-exponential analysis, anisotropy decay as well as maximum entropy methods. FeliX32™ also uses script controlled data acquisition so that specialized experimental routines can be easily created by the end user via FeliX32™ macro commands. This allows for unsurpassed flexibility in acquisition, calculation, and illustration of data.

Time Resolved Luminescence with FeliX32 ™

- **Fluorescence & phosphorescence decays**
  Measure fluorescence lifetimes down to 100 ps and phosphorescence lifetimes down to 400 ns
- **Fluorescence & phosphorescence timebased measurements**
  Study reaction kinetics
- **Gated scans**
  Time-resolved organic phosphorescence and contamination-free lanthanide spectra
- **Various collection modes**
  Collect decays in Random mode for non-biased data
- **Various time scales**
  Choose from linear, arithmetic, or logarithmic timescales for unsurpassed multiple lifetime resolution
- **For single or multiple lifetime determination**
  1-to-4 exponential and Global analysis
- **Complex decays in heterogeneous environment**
  MEM and ESM lifetime distribution analysis
- **Special kinetics, restricted geometries**
  Micelle kinetics (Infelta-Graetzel) and non-exponential decay
- **Anisotropy decay software**
  Determine rotational motion of the molecule
- **Time-Resolved Spectra (TRES) and Decay Associated Spectra (DAS)**
  Study ps-ns relaxation phenomena or spectrally discriminate components in a mixture

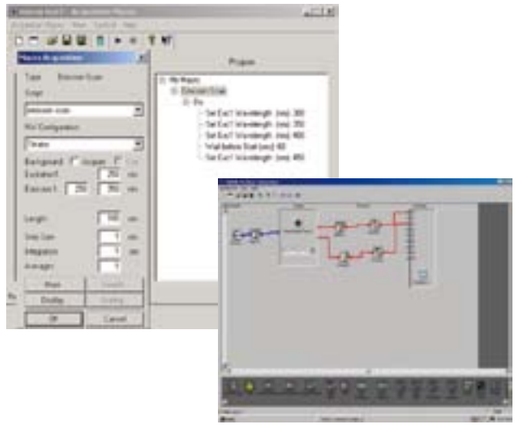


The most comprehensive software package!

Steady State Fluorescence with FeliX32 ™

- **Excitation & emission ratios**
  Determine ion concentrations using shifted probes
- **Excitation, emission, & synchronous scans**
  Determine spectra or purity of samples
- **Multidye analysis**
  Study Fura-2 for calcium and BCECF for pH
- **Time-based polarization**
  Measure antibody-antigen binding and follow structural transitions in proteins and nucleic acids
- **Automated excitation and emission spectra correction**
  Real-time excitation correction
- **Automated routine builder**
  Create and save automated protocols
- **Contour maps and 3D plots**
  Generate rotating three-dimensional plots
- **Extensive mathematical analysis tools**
  Linear fits, averages, derivative, integrations, smoothing, and much more!

**Create and save automated protocols-
Set it up and walk away!**



**One easy-to-use software
for all measurement capabilities**

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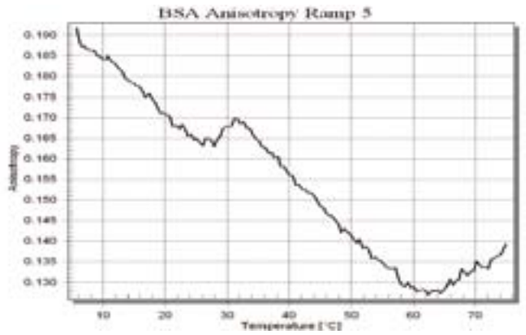
Steady State Anisotropy



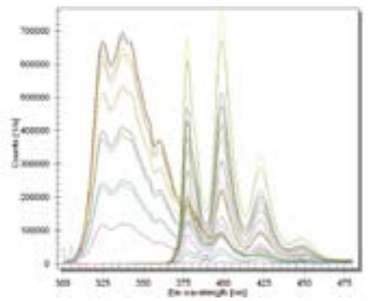
Fluorescence anisotropy of bovine serum albumin (BSA) in PBS (pH=7.4) while ramping temperature with a QuantaMaster™ equipped with dual emission channels and a rapid temperature change Peltier option.

Both photon absorption and photon emission are correlated in 3-D space with the dipole axis of the molecule. Therefore, a measurement of the polarization component of the emitted light as a function of time can yield information about the rotational mobility of the molecule under investigation. The rotational mobility of a macromolecule such as protein or DNA depends on its size and conformation. Fluorescence anisotropy measurements provide an easy and powerful tool to study conformational transitions such as protein folding and unfolding induced by temperature, pH changes, and drug or ligand binding. For fast and convenient anisotropy measurements, dual emission configurations are available to allow simultaneous determinations of vertically and horizontally polarized fluorescence signals. A software-controlled rapid temperature change Peltier unit is a valuable option for anisotropy measurements.

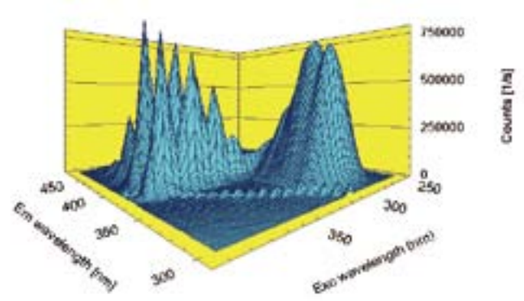
Excitation/Emission Matrix Scanning

The powerful FeliX32™ software with its user-friendly macro programming capability and the rapid scanning performance of the QuantaMaster™ make it easy to create automated acquisition protocols for measuring emission spectra at varying excitation wavelengths and creating a 3-D excitation/emission matrix. Such measurements enable the user to fully characterize spectrally complex samples very rapidly with minimum personal involvement. This means you save valuable time.

p-Terphenyl/Anthracene



p-Terphenyl/Anthracene



Rapid automated Ex/Em Matrix scan of p-terphenyl/anthracene mixture in a conventional 2-D and 3-D representation.

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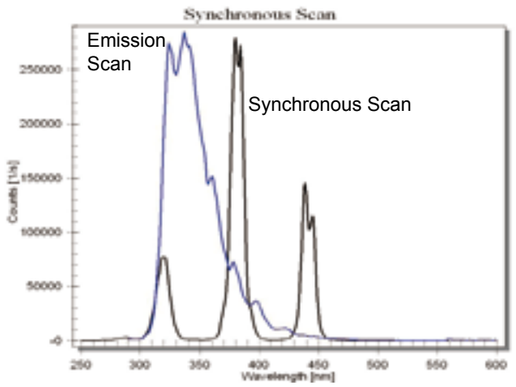
Synchronous Scans

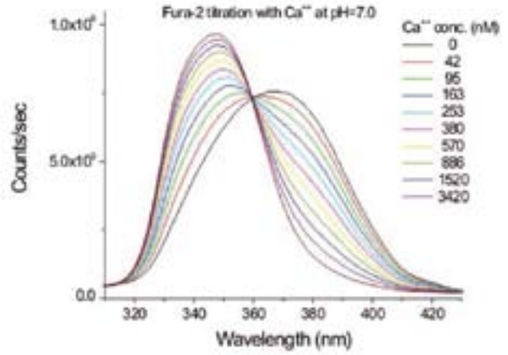


Synchronous scans involve scanning the excitation and emission monochromators simultaneously at identical scan rates, with a fixed offset between the two wavelength ranges. Essentially, these scans are performed to identify any fluorescence from the sample over the relevant wavelengths. Such a technique, known as fingerprinting, is extremely powerful in doing preliminary scans of an unknown sample where little or no information is known about the spectra. One can also identify the low concentration molecules as a function of their unique wavelength peaks unveiled in a synchronous spectrum or identify a fluorescent compound in a mixture.

The data represents a mixture of three organic hydrocarbons: p-terphenyl, anthracene, and perylene. The ordinary emission scan does not reveal the complexity or identities of the mixture. On the other hand, the synchronous scan clearly shows 3 narrow emission peaks located at the emission maxima of the respective compounds making it possible to identify the mixture components.

Ratiometric Measurements For Intracellular Ions

Excitation-shifted probes such as Fura-2 and BCECF are often used in determining intracellular calcium concentration and pH. These probes exhibit an excitation shift upon binding calcium (Fura-2) or protonation (BCECF). In these experiments, the excitation monochromator automatically alternates between two excitation wavelengths corresponding to the free and ion-bound probe. The ratio of the two signals is also measured. Pre-configured look-up tables transform the measured intensity ratio into ion concentrations or pH. Similar measurements can be done for emission shifted probes such as Indo and carboxy-SNARF.



Fura-2 titration with Ca++ ions monitored via excitation spectra (instrument: QuantaMaster™).

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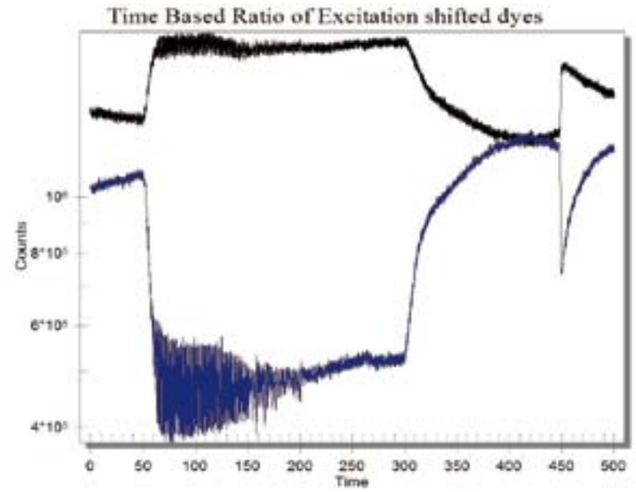
Time Based Measurements

Probably one of the most common experiments, time based measurements are useful for many applications such as enzymatic activity assays, ion activity in cells, titration studies, protein-protein and protein-drug interactions, anisotropy measurements, and chemical kinetics. The measurements involve monitoring the fluorescence intensity at fixed excitation and emission wavelengths as a function of time. The QuantaMaster™ series can do kinetic measurements on a time scale ranging from 1 millisecond to hours or days.

Kinetic measurements reveal the temporal changes in a sample at a specific excitation and emission wavelength over time. In other words, the luminescence emission can be monitored on a timescale of milliseconds to hours to allow chemical migrations or reactions to be studied in proteins or whole cells.



Automated Temperature Control

Sample temperature plays a critical role in all types of luminescence measurements. For example, when the emission based anisotropy of some fluorophores is measured the viscosity will change as a function of the temperature affecting the rotational motion of the fluorophore. The temperature control can be critical for fluorescence quantum yield determination, or any quantitative intensity measurements since the nonradiative deactivation is strongly temperature dependent. In addition, temperature control is essential in protein studies as it is the only way to measure thermal stability of proteins and their folding and unfolding characteristics.

The QuantaMaster™ series comes standard with a thermostatable cuvette holder where the plumbing is already in place for temperature control utilizing a circulating water bath. If your research requires more precise or extreme temperature control, additional solutions are available including software driven Peltier temperature control, or a liquid nitrogen based cooling device. Various automated temperature control parameters are available such as constant mode, temperature ramping, and incremental changes. To ensure temperature accuracy, the temperature can be fed back and displayed on screen in real-time.

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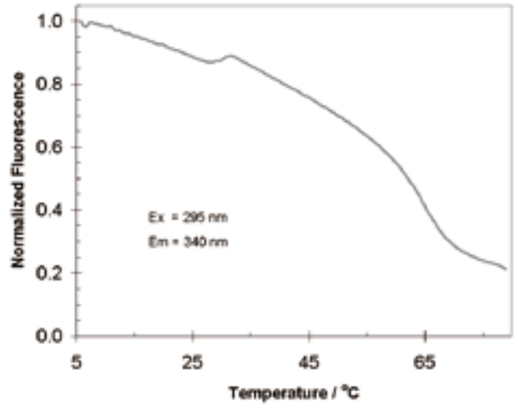
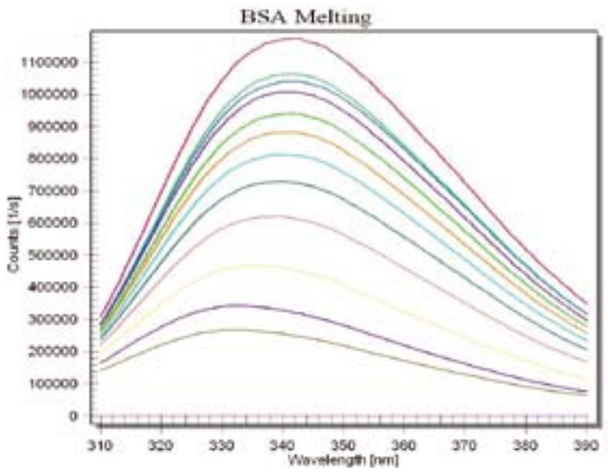
Automated Temperature Control Cont.

Temperature control is critical in such applications as:

- Temperature dependent quantum yields
- Quantitative intensity measurements
- Activation energies of photophysical processes
- Protein folding and unfolding
- Nucleic acid melting profiles
- Thermodynamic parameters of binding reactions
- Membrane fluidity and permeability studies
- Fluorescence measurements of live cell
- Enzyme kinetics



Bovine serum albumin (BSA) unfolding monitored with PTI QuantaMaster™ 4 spectrofluorimeter equipped with the rapid temperature control accessory.



Automated (macro) acquisition of BSA fluorescence spectra as a function of temperature showing the effect of thermal unfolding.

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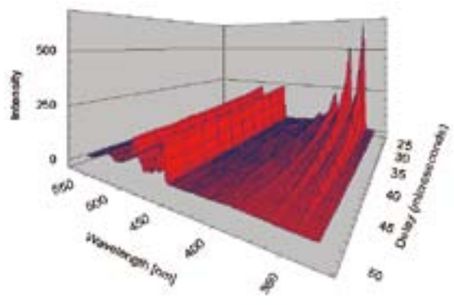
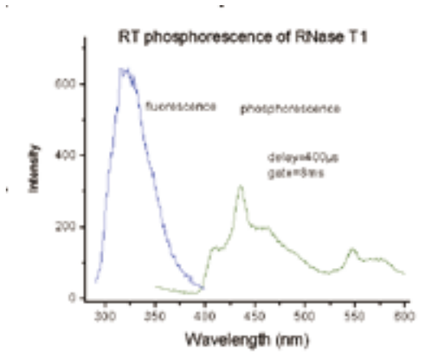
Emission Spectra Is A Powerful Technique To Discriminate Between Fluorescence and Phosphorescence



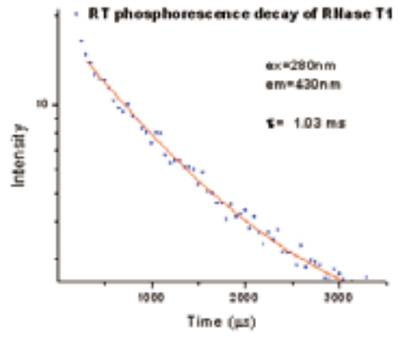
A pulsed light source and gated detection are indispensable tools in discriminating spectra based on the lifetime of the respective excited state. Fluorescence emission happens on the picosecond to nanosecond time scale, while phosphorescence occurs on the microsecond to second time scale. By varying the temporal position and the width of the signal detection gate one can selectively detect fluorescence and phosphorescence spectra as attested by phenanthrene spectra on the accompanying figure. Here, the emission of phenanthrene in a frozen glass was measured with gradually increased time delay of the detection gate to diminish contribution of fluoresence.

Phenanthrene at 77K utilizing a cold finger Nitrogen Dewar Accessory. Fluorescence and phosphorescence spectra measured while increasing the delay time (at 2.5 µs increments) on the gated detector.

However, the true potential of this technique can be seen in the case of room temperature phosphorescence (RTP) of RNase T1 tryptophan, where the signal was extracted by gating out the overwhelming Trp fluorescence – a task impossible with a continuous excitation source. Conveniently, the same instrument can be used to measure phosphorescence decay of this extremely weak emission by sweeping the detection gate in time while keeping the excitation and emission wavelengths constant.



Discrimination between strong fluorescence and weak room temperature Phosphorescence (RTP) from RNase T1 tryptophan by varying the temporal position and widths of the signal detection gate on a QuantaMaster™ equipped with a pulsed Xe lamp and gated detector.

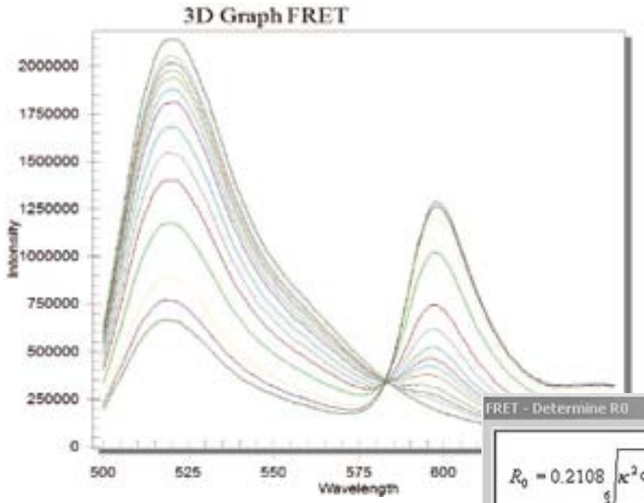


Phosphorescence decay of a weakly emitting RNase T1 tryptophan signal using the same instrument.

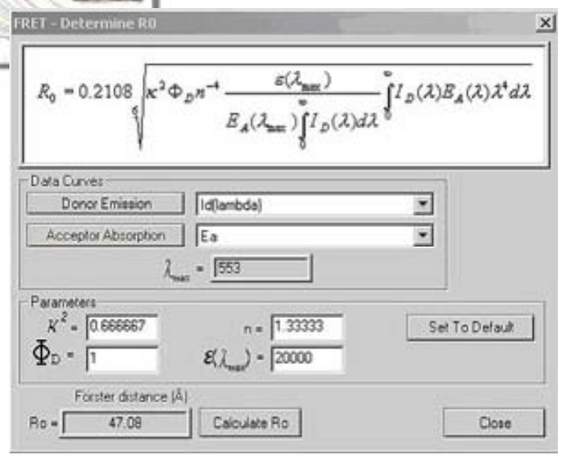
Quanta Master

Fluorescence Resonance Energy Transfer (FRET) In Steady State

Fluorescence Resonance Energy Transfer (FRET) is a technique that facilitates many research projects and has applicability over a broad range of scientific disciplines including biology, chemistry, and physics. FRET occurs between an excited donor molecule and the ground-state acceptor molecule over a range of distances, typically 10-100 Å. FRET is a nonradiative process, meaning that there is no photon emitted or absorbed during the energy exchange. The efficiency of FRET is strongly dependent on the D-A distance and is characterized by the Förster critical radius R_o, a unique parameter for each D-A pair. When the D-A distance is R_o, the efficiency of energy transfer is 50%. Once R_o is known, the D-A pair can be used as a molecular ruler to determine the distance between sites labeled by D and A. It is probably the most commonly utilized technique today for estimating distances between molecules in solution. The QuantaMaster™ series can help you take advantage of this technology easily with the built-in FeliX32™ FRET Calculator.



Titration monitored by FRET between Alexa-BSA complex and a Bodipy-labeled fatty acid.

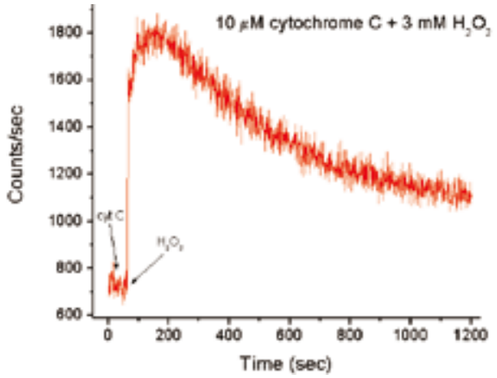


The built-in FRET Calculator can be used to calculate D-A distances.

The Fluorescence Solution Company

Other Aplications

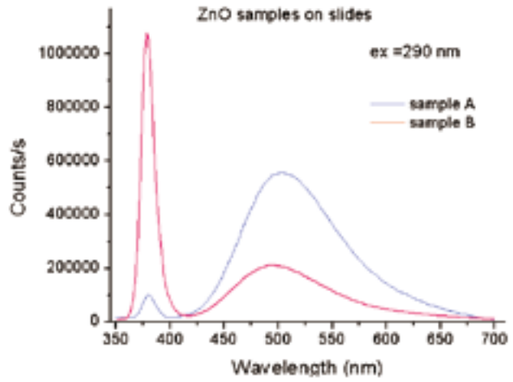
Bio- and Chemiluminescence



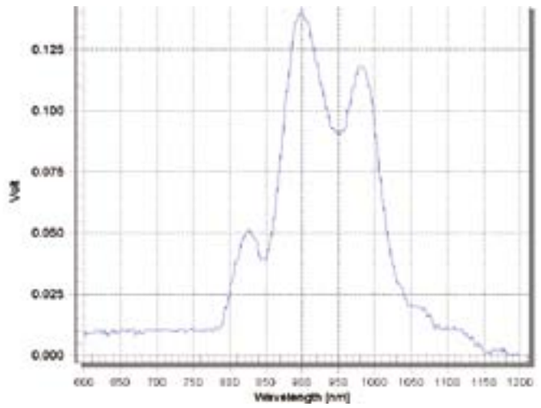
The unsurpassed sensitivity of the QuantaMaster™ detection makes it a very capable instrument for measuring extremely weak chemiluminescence emission as illustrated by the cytochrome C/hydrogen peroxide experiment.

Due to its dedicated accessories such as a well-designed solid sample holder and excellent stray light rejection characteristics, the QuantaMaster™ is an excellent choice for the semiconductors research. Here, clean spectra from strongly scattering ZnO samples were measured with the QuantaMaster™ equipped with a double excitation monochromator.

Semiconductors Research



Electroluminescence and Photovoltaic Measurements



The flexibility of the modular design makes it easy to utilize the QuantaMaster™ for more specialized applications, such as electroluminescence or photovoltaic measurement. Here, the figure shows an electrical response of a photovoltaic cell illuminated with the QM excitation monochromator equipped with an NIR grating. The electrical signal from the cell is fed directly to one of the analog inputs of our versatile BryteBox interface and the powerful FeliX32 ™ software takes care of rest!

QuantaMaster 4 CW Steady State

Sensitivity

Detection Limit	460 attomolar fluorescein in 0.1 M NaOH
Signal to Noise Ratio	10,000:1 or better Water Raman Spectrum Excitation wavelength = 350 nm Spectral bandwidth 5 nm, integration time 1s

Excitation Source

Type	Continuous xenon arc lamp
Lamp	75W, ozone free
Spectral Range	200-2,000 nm
Adjustment	XYZ, focusing, rear mirror

Monochromators

Type	Czerny-Turner	
Focal Length	200 nm	
Stray Light Rejection	10^{-4} (10^{-8} for double monochromators)	
F #	4	
Bandpass	0 to 25 nm	
Accuracy	+/- 1 nm	
Resolution	0.5 nm	0.5 nm
Minimum Step Size	0.25 nm	0.25 nm

Grating

	Excitation	Excitation
Type	Ruled	Ruled
Standard	1,200 l/mm	1,200 l/mm
Blazed	300 nm	400 nm

Options
an extensive selection of gratings optimized from 75-2400 grooves/mm is available in addition to holographic models.

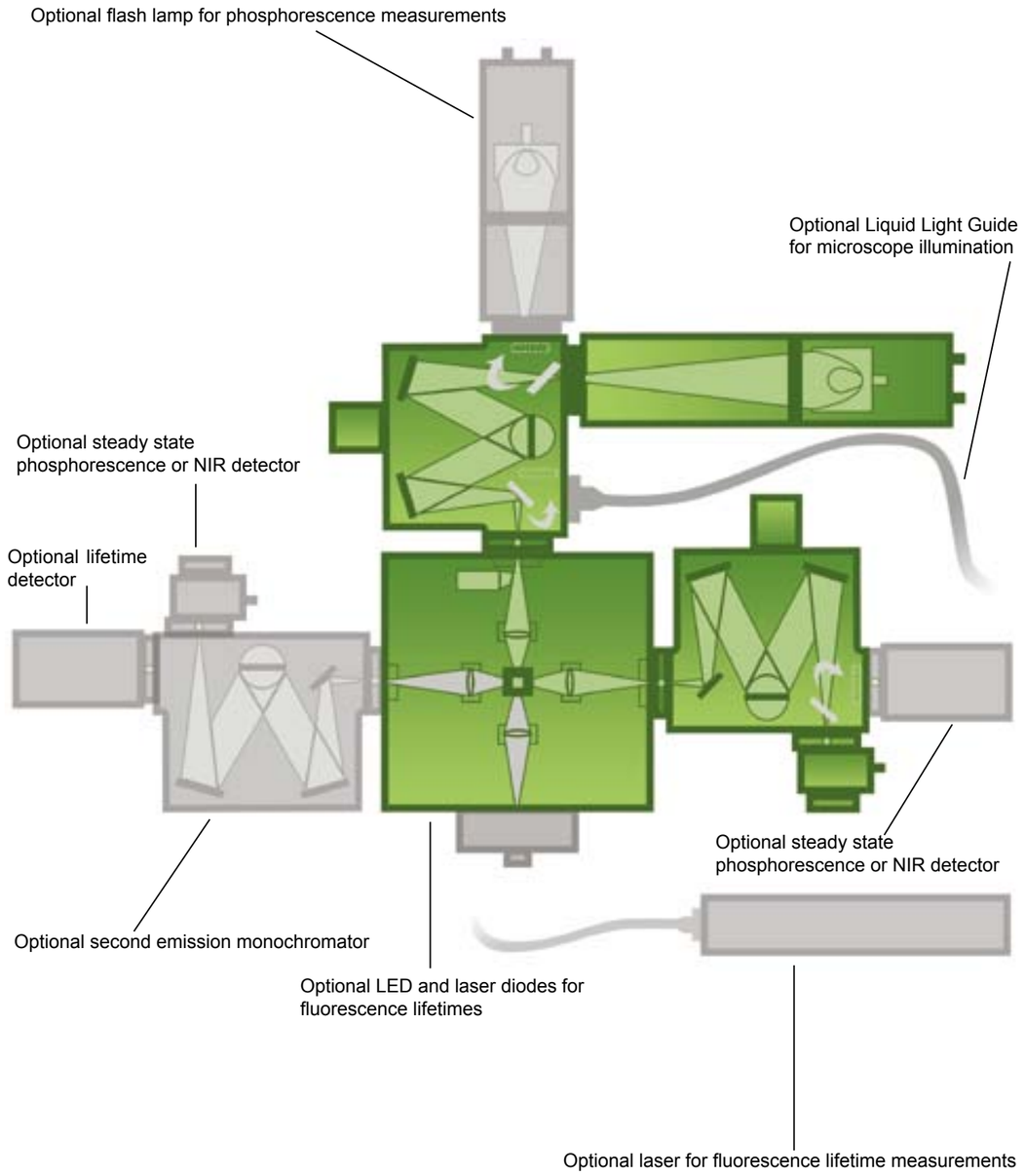
Detector

	Standard	Optional
Photomultiplier	PMT 1527	PMT 928
Spectral Range	185 to 680 nm	185 to 900 nm

Sample Compartment

PTI's universal QuadraCentric™ sample compartment comes standard with a 10 x 10 mm thermostatable cuvette holder equipped with a variable speed stirrer, high efficiency quartz optics, filter holders, active excitation correction, lid activated emission shutter, and one quartz cuvette. The Open Architecture modular design allows for numerous options such as Peltier temperature control, liquid nitrogen temperature control, polarizers, solid or powdered sample holder, cryostats, intergrating shpere, titrators, stop flows, and many other options for limitless application solutions. For sample chamber accessories see the Accessories page.

The Fluorescence Solution Company



QuantaMaster 3 Phosphorescence

Sensitivity

Detection Limit	50 femtomolar fluorescein in 0.1 M NaOH
Signal to Noise Ratio	3,000:1 or better Water Raman Spectrum Excitation wavelength = 350 nm Spectral bandwidth 10 nm, 750 flashes, 2 averages

Excitation Source

Type	Pulsed xenon arc lamp
Spectral Range	200-2,000 nm
Adjustment	XYZ, focusing, rear mirror
Repition Rate	1-300Hz, continuously tunable
Pulse Width	2 µs

Monochromators

Type	Czerny-Turner	
Focal Length	200 nm	
Stray Light Rejection	10^{-4} (10^{-8} for double monochromators)	
F #	4	
Bandpass	0 to 25 nm	
Accuracy	+/- 1 nm	
Resolution	0.5 nm	0.5 nm
Minimum Step Size	0.25 nm	0.25 nm

Grating

	Excitation	Excitation
Type	Ruled	Ruled
Standard	1,200 l/mm	1,200 l/mm
Blazed	300 nm	400 nm

Options
an extensive selection of gratings optimized from 75-2400 grooves/mm is available in addition to holographic models.

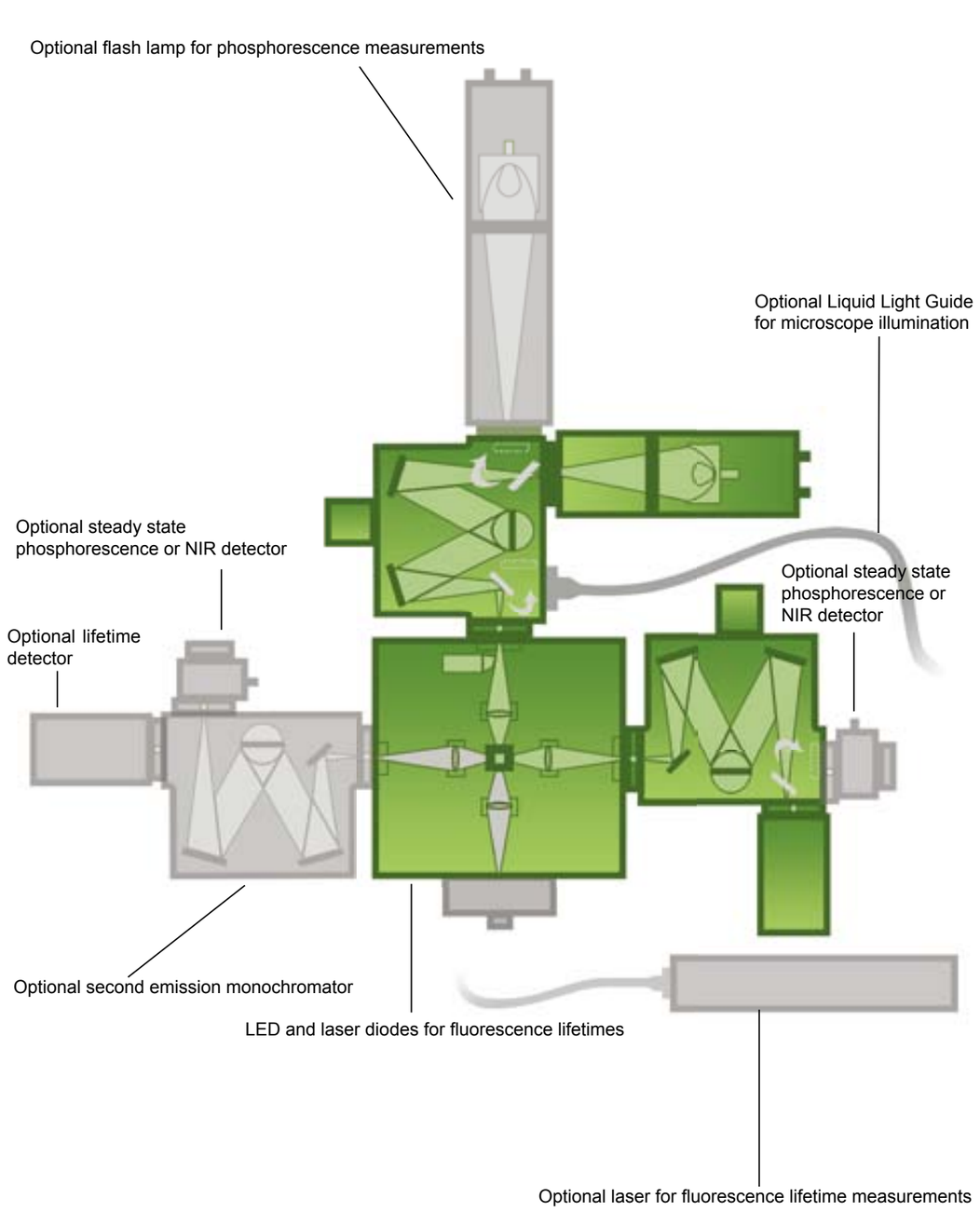
Detector

	Standard	Optional
Photomultiplier	PMT 1527	PMT 928
Spectral Range	185 to 680 nm	185 to 900 nm

Sample Compartment

PTI's universal QuadraCentric™ sample compartment comes standard with a 10 x 10 mm thermostatable cuvette holder equipped with a variable speed stirrer, high efficiency quartz optics, filter holders, active excitation correction, lid activated emission shutter, and one quartz cuvette. The Open Architecture modular design allows for numerous options such as Peltier temperature control, liquid nitrogen temperature control, polarizers, solid or powdered sample holder, cryostats, intergrating shpere, titrators, stop flows, and many other options for limitless application solutions. For sample chamber accessories see the Accessories page.

The Fluorescence Solution Company



Accessories

Stopped Flow Accessory

The stopped flow accessory is used to rapidly mix small volumes of two (or more) different chemicals in a cuvette, quickly stop the flow of chemicals to the cuvette, and monitor the resulting chemical reaction via optical means. In some instances, the chemical reaction will result in luminescence and this optical signal can be monitored using a fluorometer. In other instances, the chemical reaction only produces a change in the optical absorption properties and must be monitored using an absorption technique. The primary experimental interest is in the speed of the chemical reaction following the mixing in the cuvette, in addition to the spectral properties of the resulting absorption and/or luminescence.

Four-Position Sample Holder

The multi-position Peltier, featuring a four-position turret and magnetic stirring can accommodate standard cuvettes or microcuvettes. The automated sample holder has a controllable temperature range of -20°C to 105°C.

Titrator

Titrations are performed to measure a number of biochemical and physical parameters, including binding constants, stoichiometry and kinetics. PTI offers fully automated titration solutions that are integrated into the software. Parameters such as mixing, volume, speed, and calibration are dictated in the software and can be adapted to your needs.

Powdered Sample Holder

The powdered sample holder head easily adapts to the solid sample base with one thumbscrew adjustment. The sample head can be disassembled for easy sample loading and cleaning.

Front Faced Solid Sample Holder

The front face solid sample holder, capable of both linear and rotational travel, was designed for the measurements of solid compounds, microscope slides, or films. The solid sample holder head mounts onto a base that can be removed easily to substitute a powder sample holder head.

Remote Sensing Accessory

The remote sensing accessory allows in vitro or in vivo measurement by means of a quartz bifurcated fiber bundle or Liquid Light Guide. One fiber leg is attached to the second exit port of the excitation monochromator to provide excitation light to the sample. The second leg is attached to an open entrance port of the emission monochromator to detect the fluorescence signal emitted from the sample.

Single Cuvette Peltier

The Peltier provides unmatched temperature stability and accuracy over the controllable temperature range of -20°C to 105°C. Software selectable temperature ramping is established by setting the starting and ending temperatures in addition to the rate of change. Data points are measured in steps defined by the temperature increment. The minimum increment value is 0.1°C. Temperature is measured by a probe inserted into the sample cuvette and the actual sample temperature is constantly displayed on screen in real-time. The maximum temperature ramping speed is 20°C/ minute with magnetic stirring.

Muscle Strip Accessory

The muscle strip is inserted into a standard 1 cm cuvette, combining the lower muscle hook with unique perfusion tubes, a tension transducer with upper muscle hook, and an interface electronic control unit. The accessory can be used with any cuvette-based fluorescence system having a standard single cuvette holder complete with tension transducer and transducer mounting bracket with micrometer position adjustment.

Polarizers

PTI offers a wide variety of polarizers ranging from manual sheet polarizers to automated large aperture Glan Thompson polarizers. All configurations allow for automated software control, automatic G-factor determination, and real-time acquisition of HH, VH, VV, and HV analysis. Measure steady state anisotropy in single emission configuration or dynamic anisotropy utilizing our dual emission configuration.

Cold Finger Dewar

The cold finger dewar accessory is designed to be used with liquid nitrogen as coolant (77 K). It can also be used with organic solvent slushes at discrete temperatures above 77 K. Includes: quartz cold finger dewar that accepts 5 mm tubes, dewar holder for the sample turret or single cuvette holder, foam lid for the dewar and extension collar with altered sample chamber lid, and a sample compartment. The dewar features a suprasil quartz cold finger that passes light down to about 200 nm. Samples are placed in NMR and EPR tubes and the liquid nitrogen placed in the dewar will typically last several hours.

Integrating Sphere

Redesigned for enhanced measurement of quantum yields of solids, films, and powders. We use a 6-inch diameter sphere and attach it directly to the sample chamber on the port opposite the excitation channel. This design minimizes the effect of the excitation, emission, and sampling ports on the accuracy of the measurement. We also changed the optics inside the sample compartment to refocus the excitation beam inside the sphere by adding two optics inside the sample. One of these optics is adjustable in both X and Y planes to translate the focus inside the sphere. To collect the emission channel, a fiber brings the light from a port on the sphere into the emission monochromator through the second entrance port. A reflectively coated sample holder positions the sample in focus at the center of the sphere to provide superior direct illumination.

More QuantaMaster Solutions
Rapid Excitation QM 8

About QuantaMaster™ 8

The QuantaMaster™ is ideal for high-speed ratiometric work when equipped with a random access monochromator (RAM). The QuantaMaster™ UV VIS Rapid Excitation is the latest high-speed multi-wavelength ratio fluorescence system from Photon Technology International. It incorporates our patented DeltaRAM X random access monochromator into our standard steady state spectrofluorometer to allow for rapid excitation while maintaining all of the key functionality of our standard QuantaMaster™. In addition to all fundamental fluorescence spectroscopy laboratory applications for steady state intensity measurements such as wavelength scans, time-based experiments, and synchronous scans the QM 8 is capable of rapid ratiometric measurements.

The QM 8 allows researchers to illuminate the sample compartment for cell suspension work, and then easily move the liquid light guide from the sample compartment to illuminate a microscope for single cell work. With PTI's wide variety of accessories such as photometers, a user can then use the same electronics and FeliX32™ software to combine cell suspension and single cell work.

All of these acquisitions are easily handled by the QuantaMaster™ series while boasting the highest sensitivity in the industry. Sensitivity is one of the most important parameters when choosing a fluorometer because it allows minute traces of fluorescent materials to be detected and identified in mixtures. Applications include: identification and fingerprinting of oil samples, measurement of distances within macromolecules, dynamics of protein folding, quantification of ion concentrations, and membrane structure and functionality. These are just some of the many application areas where the QuantaMaster™ system excels.

Exclusive QM 8 Feature: The DeltaRAM X™ Random Access Monochromator

Whn PTI introduced the DeltaRAM X™ it was the next bold step in the evolution of light sources. Today, it is still unsurpassed. The compact, proprietary (patented) single monochromator design permits the selection of any single wavelength in two milliseconds or less. It is ideally suited for multi-wavelength applications as well as excitation scanning. It is easily controlled via a single low voltage signal line. Includes a 2-meter liquid light guide, for use with most microscopes and other sample handling devices. DeltaRAM X™ delivers powerful excitation wavelength from 250 - 650 nm under synch-lock computer control. Synch-lock control, locks the DeltaRAM X™ monochromator to the camera exposure or frame readout. The DeltaRAM X™ saves you money by not requiring purchase of additional excitation filters for each dye you wish to use. Synch-lock allows accurate timing to be retained between camera and illuminator.

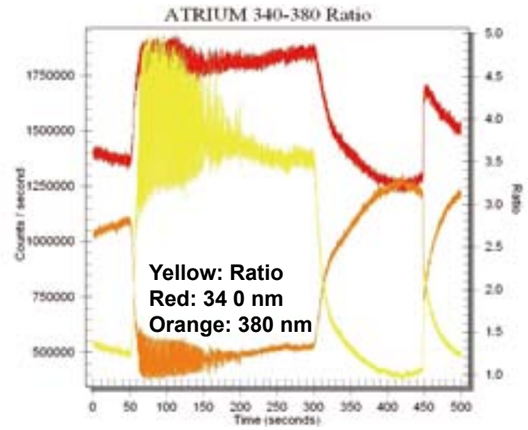
Systems not synch-locked can be plagued with synchronization problems or latency due to operating events or user clicking events. Try this in another imaging software package: click and drag a window. Either the illuminator will stop moving or images will stop being acquired until the mouse button is released. This does not happen with PTI's sync lock!

Rapid Excitation QM 8 Applications

General Applications

The QuantaMaster™ UV VIS Rapid Excitation is the latest high-speed multi-wavelength ratio fluorescence cell-suspension system from PTI and is designed to:

- Maximize dynamic range of your fluorescence probe
- Determine ideal wavelengths for any fluorescence probe
- Acquire highest quality results in challenging multiple-probe experiments
- Measure fast transients (up to 250 ratios per second)
- Perform intracellular ion measurements
- FRET
- Membrane fluidity
- Beta blockers
- RNA and DNA
- Membrane potential
- Oxidants
- Steady state fluorometry
- And many more



Freshly isolated rabbit atrium was stimulated with 90 mM KCL. 2 µM nicardipine was added and returned to normal Tyrode medium, followed by the addition of 10 mM caffeine. The Fura-2 excitation ratio signal follows the kinetics of free Ca++ in the tissue.

Ideal For Multiple Dyes

Excitation-shifted probes are typically used in determining intracellular ion concentrations. What if you wanted to measure multiple parameters at the same time? With the QuantaMaster™ series it is simple to do. The Multiple Dyes function is used to monitor multiple indicators in combination, such as Fura-2 for calcium and BCECF for pH. In this experiment, the excitation light source must alternate between four different excitation wavelengths that are characteristic of the two probes (e.g. 340, 380, 440, 490 nm). In addition, the isosbestic wavelength for Fura-2 is frequently monitored at 361 nm to obtain a calcium-independent signal.

The emission intensity resulting from excitation at the above five wavelengths is measured at the appropriate emission wavelengths (510 and 525 nm, respectively) and appropriate signal ratios are calculated. This way both the calcium concentration and pH changes can be monitored in a single experiment. Any combination of up to 10 excitation and 10 emission wavelengths may be defined to accommodate the simultaneous measurement of both excitation and emission-shifted dyes.

Rapid Excitation QM 8

Data Acquisition Characteristics

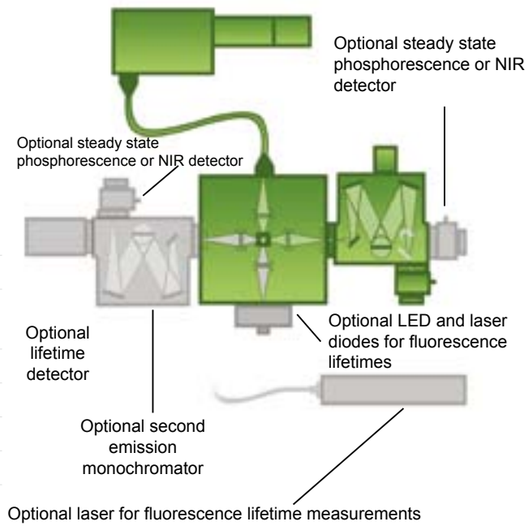
Rate (single excitation, single emission)	1000 points/sec. to 1 point/100 sec.
Rate (dual excitation, single emission)	up to 250 ratios/sec.
Excitation multiwavelength capacity	up to 10 random wavelength pairs (software limited)
Dynamic Range	FURA-2 Rmax/Rmin = 40 typ.

DeltaRAM X™ Excitation

Excitation wavelength range	330 to 650 nm
Transition speed	<2 millisec. point to point
Resolution	<1 nm
Accuracy	+3/-1 nm
Bandwidth	1-24 nm, continuously variable
Liquid Light Guide	2 mm diameter by 2 meter

Excitation Source

Type	Continuous xenon arc lamp
Lamp	75W, ozone free
Spectral Range	200-2,000 nm
Adjustment	XYZ, focusing, rear mirror



Emission Monochromator

Type	Czerny-Turner	
Focal Length	200 nm	
Stray Light Rejection	10^{-4} (10^{-8} for double monochromators)	
F #	4	
Bandpass	0 to 25 nm	
Accuracy	+/- 1 nm	
Resolution	0.5 nm	0.5 nm
Minimum Step Size	0.25 nm	0.25 nm

Emission Grating

Type	Ruled	Options: an extensive selection of gratings optimized from 75-2400
Standard	1,200 l/mm	grooves/mm is available in addition to holographic models.
Blazed	400 nm	

Detector

	Standard	Optional
Photomultiplier	PMT 1527	PMT 928
Spectral Range	185 to 680 nm	185 to 900 nm

Sample Compartment

PTI's universal QuadraCentric™ sample compartment comes standard with a 10 x 10 mm thermostatable cuvette holder equipped with a variable speed stirrer, high efficiency quartz f 1.3 optics, filter holders, active excitation correction, lid activated emission shutter, and one quartz cuvette. The Open Architecture modular design allows for numerous options such as polarizers, solid or powdered sample holder, cryostats, polarizers, titrators, stop flows, and many other options for limitless application solutions.

More QuantaMaster Solutions
NIR Solutions

About NIR

Near-infrared (NIR) spectroscopy has emerged as a valuable analytical technique, especially in the fields of material research, chemistry, and photomedicine. Powerful NIR capabilities are available through PTI as either a stand-alone research grade fluorometer or as an upgrade to PTI's UV-VIS steady state spectrofluorometers.

Expand your system at a later date to accommodate your most current research direction. Add additional light sources, detectors, or even couple your fluorometer to your microscope. No matter what fluorescence measurement capability you start with, from UV-VIS steady state to time resolved, you can always add other capabilities at a later date. There is no need to buy a new system or any additional software. Our complete software package is already prepared for additional measurement capabilities. For a list of accessories see the Accessories page.

NIR-PMT Based Steady State Systems

Comprised of a high intensity continuous xenon light source, scanning monochromators, and a cooled NIR PMT detector. Available in four models for the maximum spectral range coverage:

A) Basic 950–1400 nm
B) UV enhanced 300–1400 nm
C) NIR enhanced 950–1700 nm
D) UV and NIR enhanced 300–1700 nm

NIR-InGaAs Based Steady State Systems

Comprised of a high intensity xenon light source, scanning monochromators, a high sensitivity TE-cooled InGaAs detector, electronics, lock-in amplifier and chopper for noise suppression. The system provides unmatched NIR capability from 500 to 1700 nm or an extended version out to 1900 nm.

NIR-PMT Based Time Resolved Systems

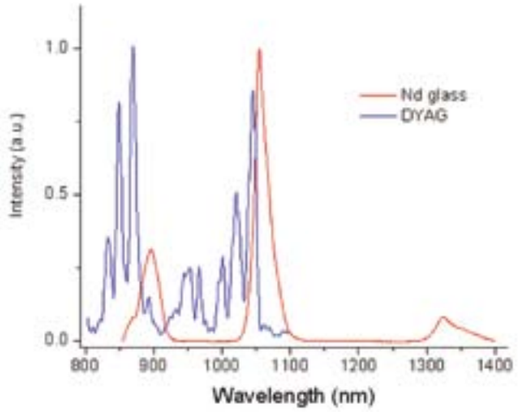
Comprised of a high intensity xenon flash light source, scanning monochromators, a high sensitivity gated TE-cooled NIR PMT detector. Available in four models for the maximum spectral range coverage:
A) Basic 950–1400 nm
B) UV enhanced 300–1400 nm
C) NIR enhanced 950–1700 nm
D) UV and NIR enhanced 300–1700 nm

For more information on NIR please request NIR Solutions Brochure

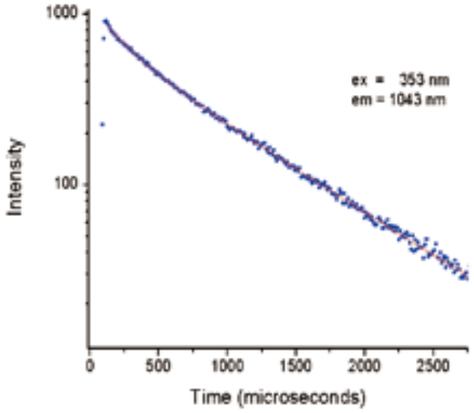
NIR Applications

General Applications

The application of NIR systems for fluorescence and phosphorescence has been in existence for a long time in materials sciences, mostly in semiconductor research. Recently, many new uses for such measurements have emerged, especially in photobiology, spearheaded by the interest in singlet oxygen. NIR measurements are particularly useful since they get away from interference in the UV and VIS part of the spectrum where many substances fluoresce. The light scattering, a notorious problem in UV-VIS fluorescence measurements, is greatly reduced as the wavelength increases. Less interference means better signal to noise with strongly scattering biological samples. NIR light can penetrate tissue at a much greater depth than the UV and VIS – a definite advantage in tissue imaging and therapeutic applications, such as PDT. There is also a considerable research effort in the optical fiber telecommunication industry to develop infrared molecular amplifiers for the transmittance window at 1550 nm. The continuing introduction of new NIR emitters coupled with better detection and lower cost systems continues to fuel the growth of NIR luminescence applications.



NIR emission from a DYAG crystal and Nd-doped glass measured with the NIR-InGaAs. High sensitivity of the instrument permits the use of narrow slits on the emission monochromator and the resolution of narrow spectral lines of DYAG.



Luminescence decay of DYAG crystal measured with the NIR-PMT system operating in the time-resolved 'gated' mode. The DYAG decay is double exponential with lifetimes of 107 us (35%) and 791 us (65%).

- **Photochemistry**
  Singlet oxygen is frequent byproduct
- **Geology**
  NIR luminescence of minerals
- **Forensic science**
  Identifying forged documents
- **Photobiology and photomedicine**
  Singlet oxygen detection (1270 nm)
- **Cancer treatment**
  Photodynamic therapy (PDT)

- **Photochemistry**
  Photodegradation caused by singlet oxygen
- **Photosensitized oxidations**
  Photo-oxidation of environmental pollutants
- **Optical fiber communication**
  Optical amplifiers (e.g. chelated Er++ , 1540 nm)
- **Agriculture**
  Development of environmentally friendly pesticides
- **And more...**

NIR Solutions

Steady State Light Source

Detection Limit	460 attomolar
Signal to Noise Ratio	10,000:1 or better Water Raman Spectrum Excitation wavelength=350 nm Spectral bandwidth 5 nm, integration time 1s

Pulsed Light Source (lifetimes greater than 400 ns)

Type	Pulsed xenon arc lamp
Spectral Range	200-2,000 nm
Adjustment	XYZ, focusing, rear mirror
Repition Rate	1-300Hz, continuously tunable
Pulse Width	2 µs

Sample Compartment

PTI's universal QuadraCentric™ sample compartment comes standard with a 10 x 10 mm thermostatable cuvette holder equipped with a variable speed stirrer, high efficiency quartz optics, filter holders, active excitation correction, lid activated emission shutter, and one quartz cuvette. The Open Architecture modular design allows for numerous options such as polarizers, solid or powdered sample holder, cryostats, polarizers, titrators, stop flows, and many other options for limitless application solutions.

Detector

PTI offers a variety of NIR detectors for both Steady State and Time Resolved measurements offering the customer the choice of the best detector to meet their needs:

Detector type	NIR PMT								InGaAs diode
Model	SS1.4R	SS1.4X	SS1.7R	SS1.7X	P1.4R	P1.4X	P1.7R	P1.7X	TE1.7
Application	Steady State				Time-Resolved				Steady State
Spectral Range (nm)	300-1400	950-1400	300-1700	950-1700	300-1400	950-1400	300-1700	950-1700	500-1700
Cooling Method	liquid N_2	TE	liquid N_2	TE	liquid N_2	TE	liquid N_2	TE	TE
Operation Temp (^oC)	-80	-60	-80	-60	-80	-60	-80	-60	-30
Minimal Measurable Lifetime	NA				500 ns				NA

Excitation and Emission Monochromator

Specifications using standard 1200 line/mm ruled grating

Focal length: 200 mm
Aperture ratio: f/4
Optical design: Czerny-Turner configuration
Wavelength range: 180 nm to 24 microns with appropriate grating
Bandpass: continuously adjustable from 0 to 25 nm
Resolution: 0.5 nm
Accuracy: +/-1 nm
Reproducibility: +/-1 nm
Minimum step size: 0.25 nm

Excitation Grating

1200 groove grating blazed at 500 nm (standard)
Options: An extensive selection of gratings, ruled and holographic, optimized from 75-2400 grooves/mm is available

Emission Grating

600 groove grating blazed at 1.2 microns
Options: An extensive selection of gratings optimized from 75-2400 grooves/mm is available in addition to holographic models.