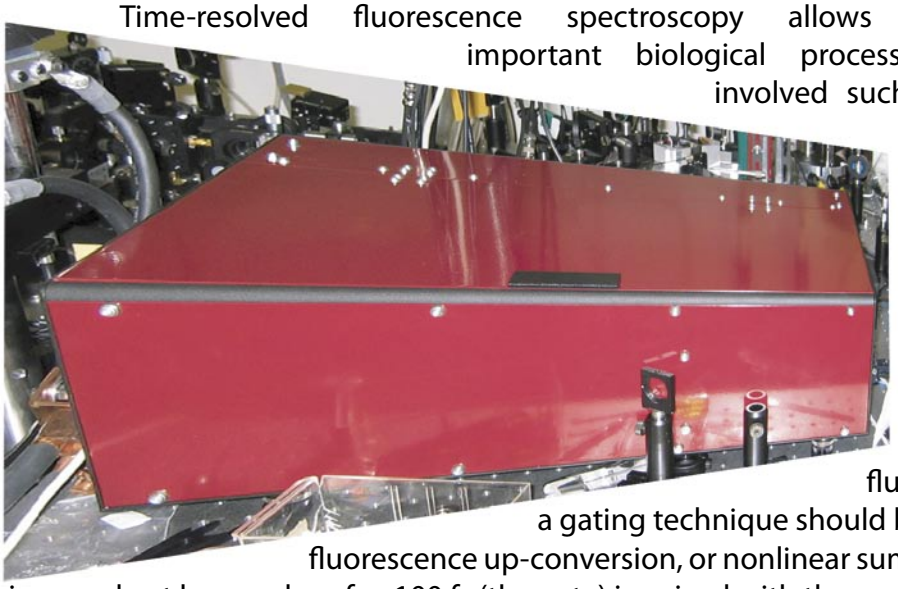
Beacon

Femtosecond Fluorescence Upconversion Spectrometer

In many biological, chemical, and physical systems, time-resolved fluorescence contains crucial information about the structures and interaction of the chromophores. The applications of the time-resolved emission include but are not limited to the studies of biological macromolecules, various aspects of intra- and intermolecular dynamics in liquids such as vibrational cooling or solvation dynamics, ultrafast carrier dynamics in quantum dots, fluorescence anisotropy, etc. Time-resolved fluorescence spectroscopy allows real-time investigation of important biological processes in which photons are involved such as the process of vision or photosynthesis.



In ordinary subpicosecond pump-probe transient absorption technique, the spontaneous emission signal remains time-unresolved and usually forms time-independent background signal. To introduce time-resolution into the fluorescence measurements, a gating technique should be implemented, one of which is fluorescence up-conversion, or nonlinear sum-frequency mixing. In this technique, a short laser pulse of ~ 100 fs (the gate) is mixed with the emission excited in the sample by another 100 fs pulse producing a signal at the sum $\omega_g + \omega_{em}$ optical frequency. The power of the sum frequency generated, P_3, is given by $P_3 = \alpha P_1 P_2 l^2 (\omega_{sum}/\omega_{em})$ (where P_1 and P_2 are the powers of the gating and fluorescence pulses, respectively, α is a coefficient related to the crystal nonlinearity, and l is the lengths of the crystal) and, therefore is directly proportional to the fluorescence intensity. Time-dependent data is obtained by optically delaying the gate pulse with respect to the excitation pulse.

Del Mar Photonics up-conversion spectrometer, Beacon, has been specially designed for measuring fluorescence lifetimes in the 400-1500 nm spectral range. Beacon can work with either a mode locked Ti-sapphire oscillators or Ti-sapphire amplifiers.

After ultrafast excitation of the sample, the emitted light is collected and focused onto the nonlinear crystal where it is mixed with the gate pulse. The change of temporal delay between the pump and gate pulse is realized with a variable delay-stage. The sum frequency signal is collected by an arrangement comprising reflectors, filters, a monochromator and a PMT, Figure 1.

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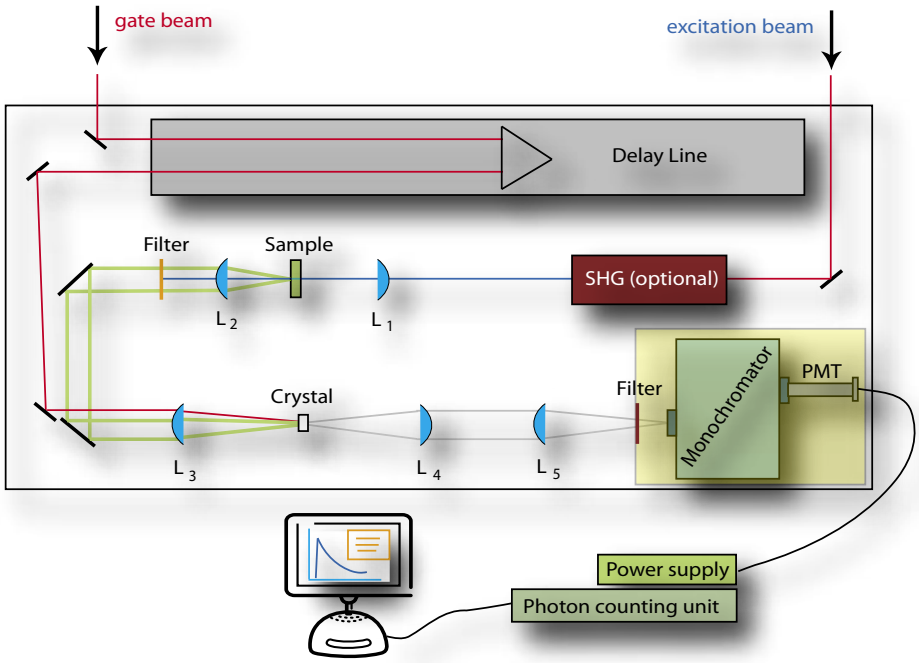

Figure 1. The schematic layout of Beacon spectrometer
$L_{1...5}$ - focusing lenses

Since the mixing takes place only during the presence of the second laser pulse, this provides time-resolution comparable to the laser pulse-width (100 fs). The software supplied with the Beacon controls the delay stage, the monochromator and data acquisition.

	Standard	Optional
Spectral Coverage	400-1500 nm	
Time scale	1600 ps	3200 ps
Step size	6.7 fs	13.4 fs
Temporal resolution	<140 fs (for 100 fs pulse)	
Repetition rate	1 KHZ - 100 MHz	
Minimum power	600 mW (for Ti:Sapphire oscillators)	
Software	LabVIEW based software Beacon 6.5	
Output data format	2D (time, emission intensity, or wavelengths, emission intensity) 3D (wavelengths, time, emission intensity) ASCII data table file format that can be viewed and analyzed by standard scientific graphing and analysis software packages (Sigma Plot, Origin, etc.), or custom-made LabVIEW software	
Footprint	W24" x L36" x H10"	

Optional: Polarization optics can be installed for polarization-dependent fluorescence measurements unit.

Optional: Frequency doubler for femtosecond Ti:sapphire laser can be installed inside the optical unit.

Beacon spectrometer comes with magnetic drive stirring system, sample holder, magnetic stir bars and a 2 mm thickness sample cell.

Where Del Mar Photonics product's names come from?
Del Mar means "by the sea", and Photonics is all about optical waves. So we decided to choose terms popular in surfing and sailing communities. Our femtosecond lasers, amplifiers and system are named after popular surf breaks around the world, and many other products named after sailing and nautical terms. Beacons are fires lit on hills or high places often used as lighthouses for navigation at sea. Today Old Point Loma Lighthouse is the centerpiece of Cabrillo National Monument, with a spectacular view of San Diego Harbor.

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