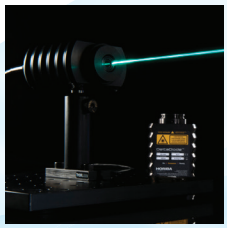
HORIBA

Fluorescence

Burst Mode Phosphorescence Decay with Fluorolog-QM using Picosecond DeltaDiode Lasers



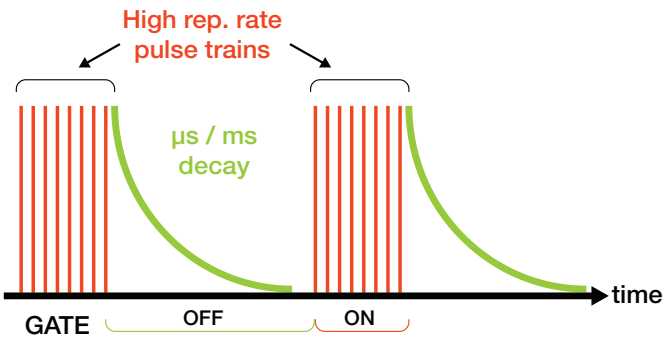
Technical Note
09092024

Introduction

Measuring phosphorescence lifetimes spanning from microseconds to seconds typically requires different light sources than those used for the picosecond and nanosecond time domains. HORIBA's picosecond DeltaDiode lasers are excellent sources for short fluorescence lifetimes, but because of their short pulse duration, they are useless for long phosphorescence lifetimes if used with the standard TCSPC protocol. Phosphorescence decays are typically measured with the Multi-Channel Scaling (MCS) mode of the TCSPC electronics using either SpectraLEDs with the software-controlled pulse width or a microsecond Xe flash lamp.

However, all DeltaDiode lasers can be operated in burst mode under software control from Felix FL software. Burst mode works by increasing the repetition rate of the laser to its maximum value of 100 MHz (or 25 MHz depending on the laser selected). This 'train of pulses' can then be gated on and off by a TTL pulse from the DeltaHub TCSPC electronics. Since the emission decays studied with this technique are long-lived, to the sample this gated pulse train will appear like a continuous excitation pulse. The duration of the gated pulse is software-controlled allowing for optimization of sensitivity and lifetime range.

Operating the DeltaDiode laser this way, you do not have to purchase a different, longer-duration pulsed light source, like Spectra LED or a pulsed Xe lamp for phosphorescence measurements.



Train of DeltaDiode laser pulses can be adjusted to create a 'super pulse' for long-lived lifetimes

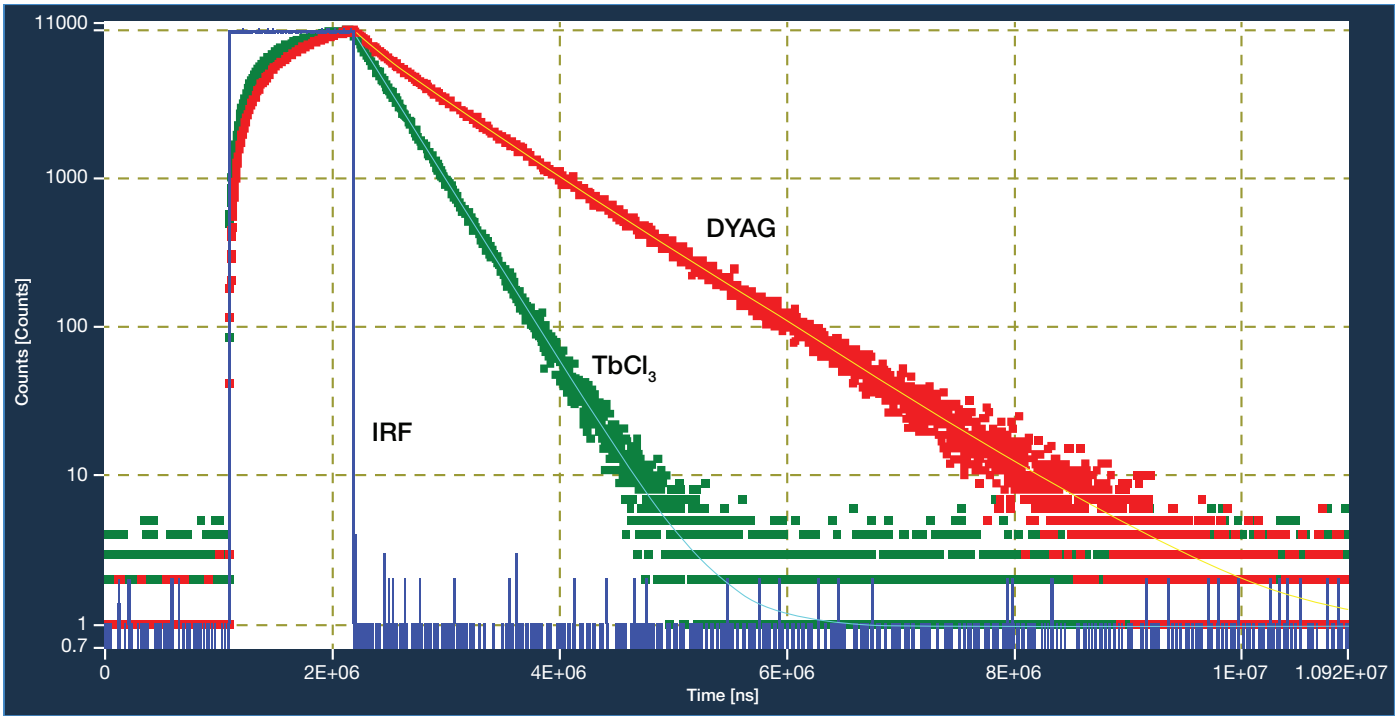
Burst Mode Setup with Felix FL

Required Components include a DeltaDiode laser, a DeltaHUB, a cable with a 4-pin LEMO connector (SpectraLED type), and a 1-pin LEMO connector

Connection Steps begin with attaching the 4-pin end of the cable to the SpectraLED output on the DeltaHUB and connecting the 1-pin end of the cable to the Fast Gate Input on the DeltaDiode controller. We then create a TCSPC/DeltaHub hardware configuration in Felix FL and select SpectraLED as the light source. And finally, access the DeltaDiode controller menu screen, navigate to the Fast Gate setting, and set it to 'Lase when High.' The last step is to adjust the DeltaDiode repetition rate to the maximum (e.g., 100 MHz) for optimal performance.

Measuring Phosphorescence Decays Acquisition Settings in Felix FL:

First, select the time range by going to Acquisition Settings, and choose a Time Range between 340 µs and 11 s. To configure excitation pulses set the Start and Duration for the excitation pulse train. Define parameters such as Emission wavelength, Emission Slit Width, Channel Count, and Stop Method, and begin the acquisition process to measure phosphorescence decays.



Long-lived photoluminescence decays of $TbCl_3$ in water (τ = 356 us) and DYAG crystal (τ_1 = 359 us, τ_2 = 890 us) measured with DeltaDiode 375L laser operating in burst mode at 100 MHz

Important Note

Before returning to standard fluorescence TCSPC measurement, ensure that the Fast Gate mode in the DeltaDiode controller is disabled. Failure to do so will prevent the DeltaDiodes from pulsing correctly

Conclusion

Using burst mode for phosphorescence decays with DeltaDiode lasers and DeltaHUB allows for comprehensive photoluminescence decay measurements from picoseconds to seconds without requiring multiple light sources.

This method enhances signal-to-noise ratio and provides a versatile tool for investigating long-lived emissions in various applications. Follow the setup and measurement procedures outlined in this technical note for optimal results.

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