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Time-resolved fluorescence measurements in real-time

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Real-time, time-resolved fluorescence spectroscopy has historically been difficult, if not impossible in many circumstances, to perform for molecules with extremely fast decay rates. The decay rates are often critical in distinguishing molecules that have similar absorption/emission characteristics. Methods that are not performed in real-time, such as time-correlated single photon counting, have thus been used. However, these methods require that the samples be excited many times in order to build a histogram of the fluorescence decay with time. Such methods are not suitable for many biological samples because they are slow and biology is very dynamic. Furthermore, the samples can be damaged due to photobleaching and other light-initiated reactions. Recent technological advances have made real-time, time-resolved fluorescence possible for many biomolecules with rapid decay rates. A new instrument has been designed using a highly sensitive, fast rise-time photomultiplier tube (PMT) with a large dynamic range. The PMT, together with ultra-high speed analog and digital signal processing is able perform real-time time-resolved fluorescence spectroscopy for decay times as fast as 80 ns. The PMT signal is filtered and amplified by a 275MHz bandwidth transimpedance operational amplifier which is then sampled by a 16bit ADC. On the fly averaging in an FPGA then minimizes the thermal noise while reducing the total data that must be stored for analysis. The data can then be analyzed on a PC or, for a mobile instrument, on a Digital Signal Processor. Future instruments are expected to be capable of resolving fluorescence decay times as fast as 1.3ns.

Biography

Jerrie Fairbanks is a fourth year Electrical Engineering PhD student minoring in Biomedical Engineering at the University of Arizona. He is passionate about high speed instrumentation systems, analog and digital integrated circuit design, and embedded systems. With his time at Superior Controls Inc. he helped develop and install quality control systems for the automotive industry. He has had experience programming in many different languages for Superior Controls Inc., Power Innovations Inc., Piezo Energy Technologies Inc., and the Powers Laboratory. He has also had opportunities to research insect vision and electrophysiology in the Higgins Laboratory.

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