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Measuring Photosynthetic Health Through Delayed Fluorescence: a New Device and Biometric for Environmental Health

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Photosynthetic organisms exhibit delayed fluorescence (DF) emissions related to chlorophyll in their photosystem II complex. These emissions are weak, accounting for only 0.03% of the total fluorescence emission, and can only be found in healthy, photosynthetically-active cells in living systems. Emission lifetimes, if detected with high sensitivity, can be used as a non-invasive biomarker of an organism's health. To the best of our knowledge, while DF emissions have been studied previously in phytoplankton species, no investigations have been conducted on algal organisms that also exhibit bioluminescence. The Dinoflagellate species *Pyrocystis fusiformis* is a marine alga that bioluminesces in response to mechanical shear stress exerted on its cell membrane. We have developed a novel silicon photo-multiplier (SiPM) Geiger-mode photon-counting technology to characterize time-resolved DF behaviour in *P. fusiformis*. Here we shall discuss advancements made in our new photon-counting instrument and integration of a cooling chamber to improve the low signal to noise ratio to sensitively capture bioluminescence and DF for comparison across various environmental stressors such as methane, CO₂ and phosphorus. With the development of this low-cost, portable photon-counting device, we plan to study the impact of these environmental stressors on DF emissions of *P. fusiformis* in support of our overarching goal of examining indicators of photosynthetic environmental health in aquatic ecosystems.

Keyword-1

Delayed fluorescence

Keyword-2

Photon counting

Keyword-3

Environmental health

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