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Micro Flow Cytometry Miniaturisation - Towards in-situ Optical Phytoplankton Analysis

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The use of flow cytometry for studies of temporal and spatial variability of phytoplankton populations is a valuable tool contributing to research relating carbon biogeochemistry and climate change. Early designs and marine deployments of such devices started over two decades ago [1-3]. Miniaturisation and cost reduction without sacrificing performance remains a major challenge but would enable mass production and deployment. Large numbers of measurement nodes (e.g. as part of a global ocean observation system) would be possible which would increase data available over both spatial and temporal scales.

This research presents two different design approaches for miniaturisation and integration of optics into a microfluidic cytometer chip. The proposed solutions are suitable for micro cytometers with external components coupled with optical fibres and were simulated and optimised using ray tracing software (Zemax).

The two designs address light delivery for excitation of particles within the measurement region of the cytometer. One uses an integrated micro lens (fabricated in the chip) and the other a ball shaped micro lens manufactured separately and then inserted into the chip. Both approaches collimate the excitation light beam (from an off chip diode laser coupled with an optical fibre) into the fluidic channel. The predicted (by ray tracing) excitation beam widths are 70 and 80 μm for the integrated and the ball lens respectively, and are in agreement with experimental data presented. The proposed cytometer chip design is compatible with low cost materials (acrylic glass, cyclo-olefines) and manufacturing methods (micro milling, hot embossing, injection moulding).

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