Novel geometries for optical trapping, manipulation and visualization of live cells

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Traditional optical trapping systems comprise of the same primary optical components, namely high numerical aperture (N.A.) objective lenses and solid-state dielectric-based lasers. However, the necessity of high N.A. lenses (with an accompanying high magnification) and expensive laser sources has severely limited the practical applications of optical trapping. For example, high numerical aperture lenses limit the field of view over which trapping can be visualised and are also impractical for trapping applications that require a long working distance. It has therefore proven difficult to simultaneously trap, manipulate and visualize cells within a large population. Furthermore, although solid-state lasers with dielectric gain media provide excellent beam quality and stability, they add considerably to the cost of the optical trapping system. As a consequence, novel photonics geometries and trapping methods are required to bridge this technology gap.

We report an alternative configuration which incorporates a low N.A. lens and a vertical external cavity surface emitting laser (VECSEL) source for live cell trapping. The system uses a single 10x/0.4NA lens for both imaging and trapping which permits visualization and optical trapping of T cells over an area of >1mm^2, which far exceeds that possible using high magnification, high N.A. lenses. The 'point and click' interface of the system allows rapid 'on the fly' controlled movement of the T cells within the field of view, which thus circumvents the need for pre-programming the beam path and eliminates sample movement and therefore minimizes mechanical perturbation.

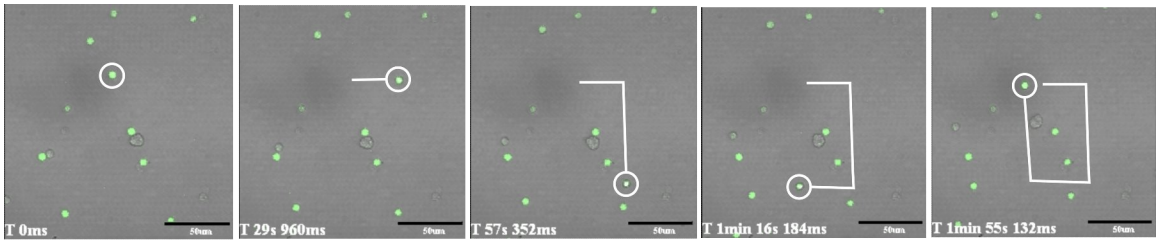

Figure 1: Snapshots demonstrating trapping and controlled movement of a single T cell within a large cell population using the VECSEL

We will describe the trapping method and optical system, and present movies of live T cell and dendritic cell interactions to demonstrate the efficacy of this low-cost technique.