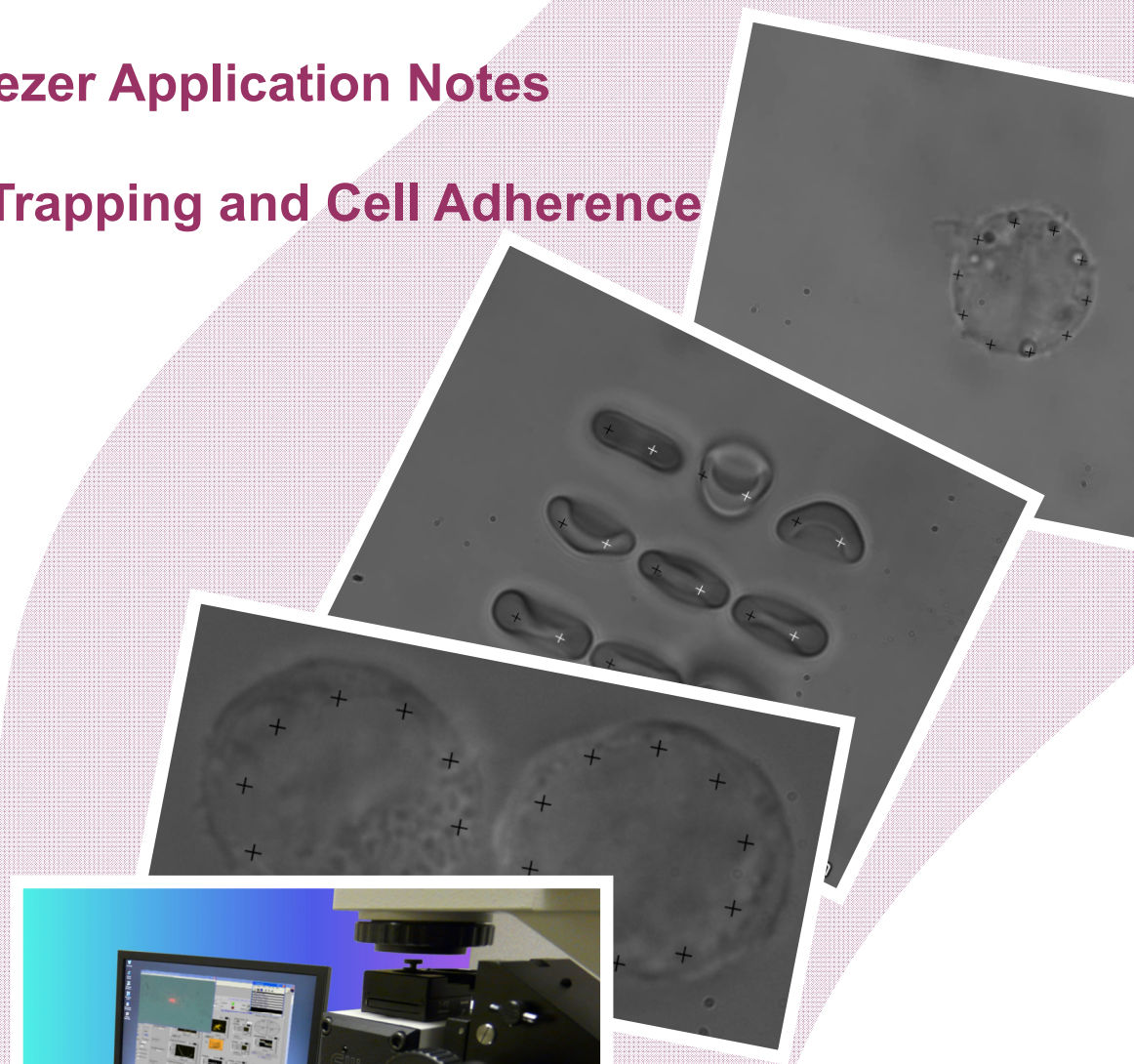
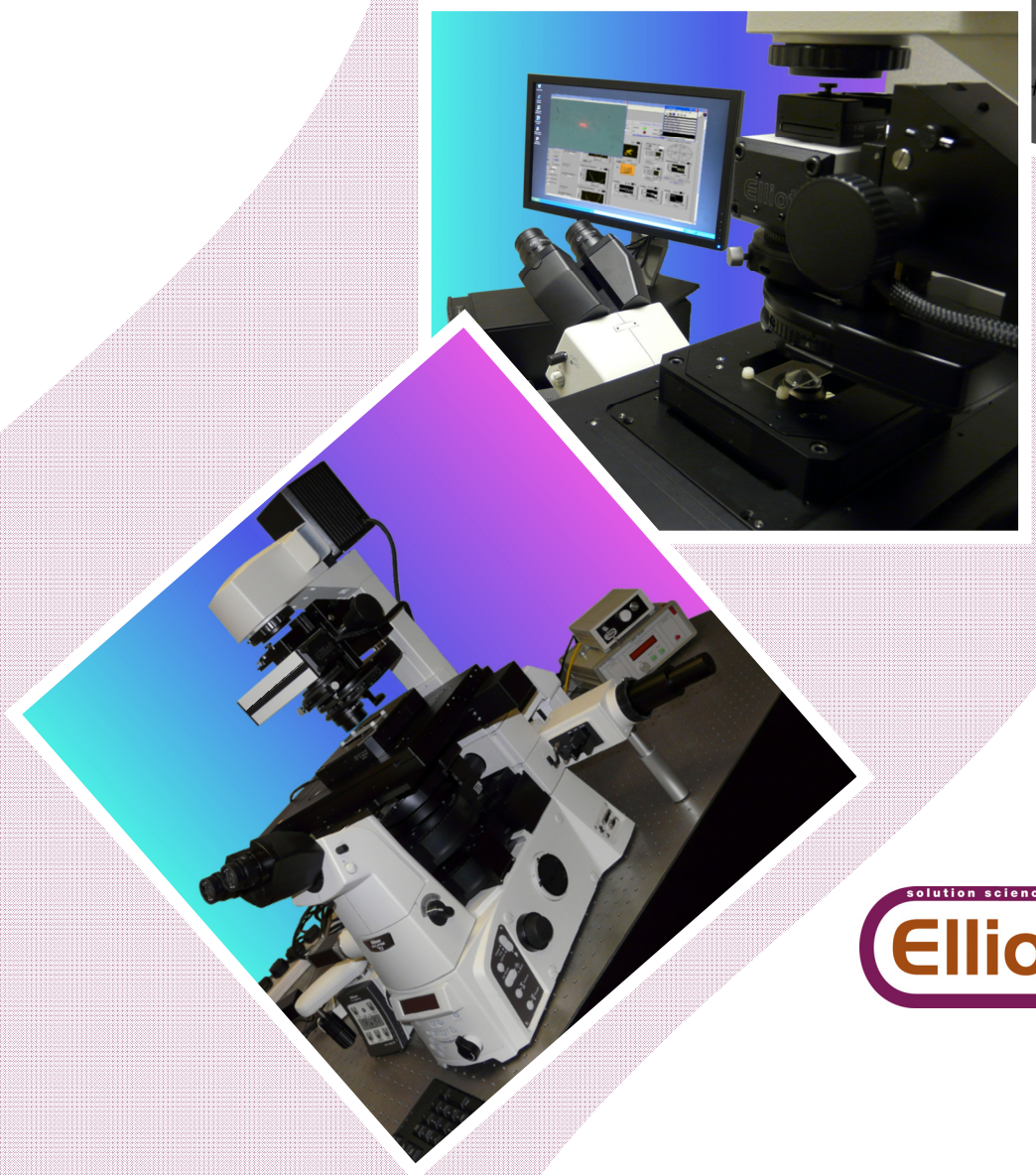
Optical Tweezer Application Notes

2. Multicell Trapping and Cell Adherence





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ELLIOT SCIENTIFIC OPTICAL TWEEZERS APPLICATION NOTES

2. TRAPPING AND MANIPULATION OF MULTIPLE CELLS AND CELL ADHERENCE

The Elliot tweezers system uses an acousto-optic deflector (AOD) to trap and manipulate multiple particles simultaneously. AODs time share the light beam between each site. The slow diffusion (random walk) of trapped objects mean this method is very powerful due to the rapid switching time (microseconds) of AODs. Here we demonstrate the versatility of the Elliot system by organising arrays of microspheres and cells into two dimensional arrays.

Samples (accompanying videos are available):

- **Microspheres (MS)** – 2 μm polystyrene microspheres, in filtered water.
- **Algae (TRA)** - *Trachydiscus minutus*, a small variety of algae that provide a plant-based source of omega-3 oils, suspended in filtered water.
- **Red Blood Cells (RBC)** – human erythrocytes, suspended in a solution of Phosphate Buffered Saline and 0.1% Bovine Serum Albumen (added to reduce cell-cell and cell-glass adhesion). The trapping chamber was also coated in Poly-HEMA (in ethanol, 20 mg/ml) to prevent cells from sticking to the surfaces of the glass trapping chamber.

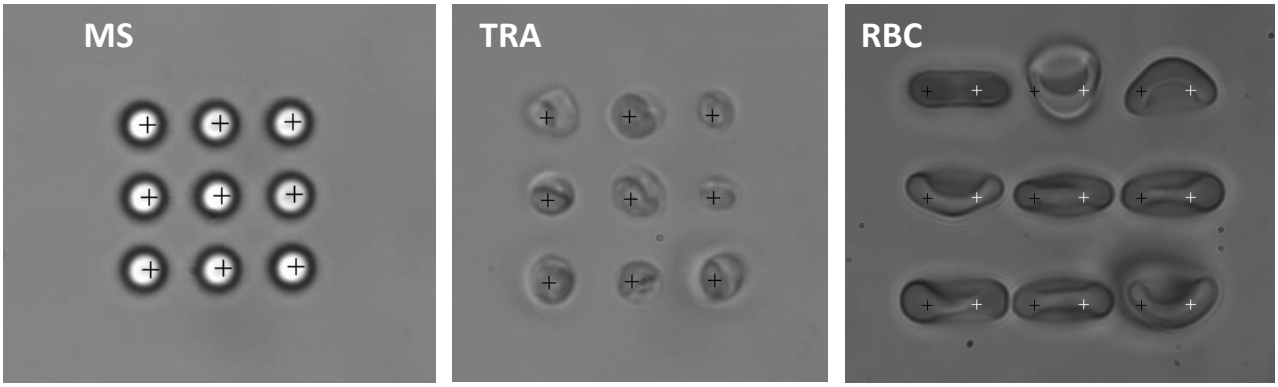

Figure 3: The Elliot AOD trapping system allows patterning and positioning of arrays of trapped particles and cells. Laser power (at objective back aperture), for the microspheres, TRA and RBC samples was 350 mW, 700 mW and 160 mW respectively. To ensure the RBCs are held in the same orientation, two 3x3 trap arrays with a horizontal offset between them are used. Accompanying videos are available.

Furthermore, we can utilise this system to perform studies of cell adherence as demonstrated in the following case study.

Human Embryonic Kidney (HEK293) cells were prepared as samples. These were grown under standard culture conditions (37 °C, 5% CO_2), trypsinised and suspended in culture medium (Minimum Essential Medium Eagle supplemented with 10% Foetal Calf Serum and antibiotics (2 mM L-glutamine, 100 units penicillin and 0.02 mg streptomycin per mL). The trapping chamber was coated in Poly-HEMA (in ethanol, 20 mg/ml) to prevent the cells from sticking to the surfaces of the glass trapping chamber.

In the picture below we see two tripsinised HEK cells, each held in a circular array of optical traps. The circular arrays were positioned to bring the cells into contact, as seen here. After 30 seconds, the cells can be seen to be firmly attached to one another – when one trap array is moved the cell pair clearly demonstrate coupled motion and the cells could not be separated by pulling the trap arrays apart. Demonstrations of this can be seen in an accompanying video.

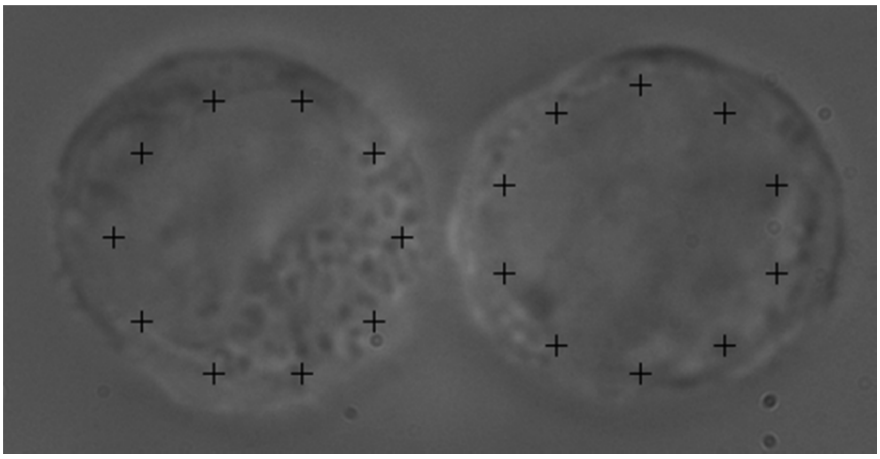

Figure 4: Cell-cell adhesion was readily achieved in the Elliot system by utilising arrays of optical traps to securely hold a pair of HEK cells in contact for ~30 s, after which time the cells could not be separated and demonstrated clear coupled motion. Laser power (at objective back aperture) was 255 mW. Accompanying videos are:

- 3x3 Grid Manipulation
- 5x5 Grid Manipulation
- TRA Array
- HEK Adhesion
- RBC Array
- RBC Flip

This case study was performed at the University of St. Andrews using a standard Elliot Scientific E3500 AOD Optical Tweezers system.

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