OPTICAL TRAPPING AND MEGA-HZ TRACKING TO INVESTIGATE THE MECHANICS OF MACROPHAGE FILOPODIA

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KEY WORDS: Live cell imaging, fluorescence, optical traps, interferometric tracking, laser manipulation, cell mechanics

MACROPHAGES TAKE UP PARTICLES USING FILOPODIA

Macrophages are immune cells which take up and digest cell debris and bacteria in the body in a process which is called phagocytosis. Macrophages exhibit extensive surface ruffles and filopodia that they use to bind particles and pull them towards the cell. Filopodia are thin, needle-like protrusions of the cell that contain filamentous actin bundles and are connected with the cell membrane via linker molecules. The stepwise binding and multistep retraction of the particles is a process which requires the cell to both sense mechanical stimuli as well as apply controlled mechanical forces to the environment [1].

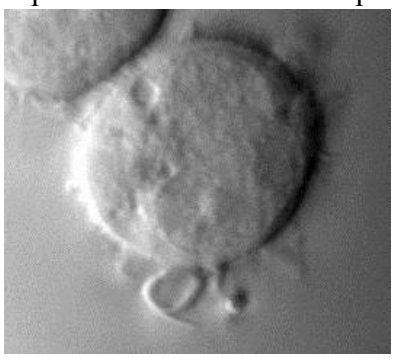

Figure 1: Macrophage cell pulling on bead

TRAPPING AND MEGA-HZ TRACKING TO ANALYZE PARTICLE UPTAKE

We use a Photonic Force Microscope in which we combine DIC microscopy and fluorescence microscopy with optical tweezers and interferometric particle tracking. Polystyrene beads as model bacteria are held in an optical trap to enable controlled placement in the vicinity of the cells. The motion of the bead in the trap can be tracked in 3D with nanometer precision at a micro-second timescale using back focal plane interferometry [2]. This configuration enables us to induce and analyze cellular responses down to the single receptor level in a reproducible investigation scheme. By changing the optical forces spatially or temporally, we investigate how the cell reacts to external stimuli.

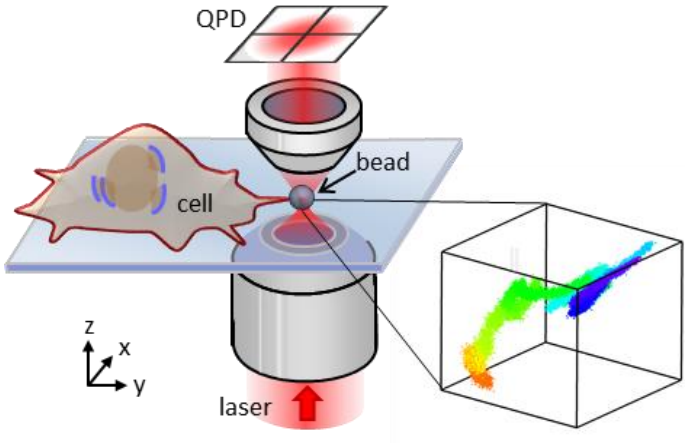

Figure 2: Schematic of microscope setup

[1] H. Kress, E.H.K. Stelzer, D. Holzer, F. Buss, G. Griffiths, A. Rohrbach "Filopodia act as phagocytic tentacles and pull with discrete steps and a load –dependent velocity", *PNAS* ,104**,** 11633–11638 (2007).
[2] F. Jünger, F. Kohler, A. Meinel, T. Meyer, R. Nitschke, B. Erhard, A. Rohrbach „Measuring local viscosities near plasma membranes of living cells with photonic force microscopy" *Biophysical journal*, 109(5), 869-882 (2015).