

Investigating Phagocytosis by Optical Trapping and Tracking

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Macrophages internalize bacteria during phagocytosis, which is a central mechanism in the immune system. Still, only little is known about the mechanical properties of phagocytosis, in particular when mediated by cellular tentacles, i.e. filopodia. We used optical tweezers-based

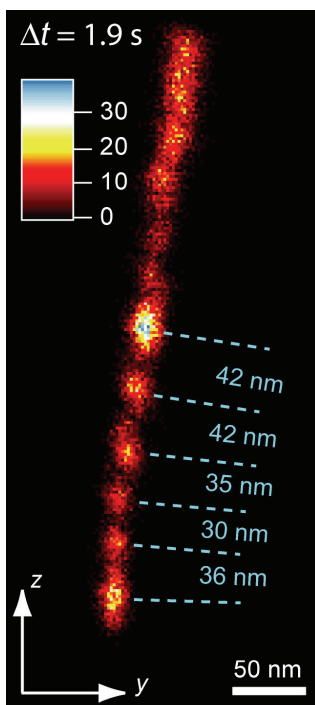


Fig. 1: Position histogram of motor steps inside the cell.

microscopy to investigate different mechanical concepts of the cell to take up 1 μm beads, which serve as synthetic bacteria. The motions of optically trapped beads either connected to filopodia or to the flat membrane were tracked interferometrically in 3D with nanometer precision at a microsecond timescale. On the one hand, the measurement of the thermal bead fluctuations during the binding to the cell membrane enabled the observation of individual receptor-ligand bond formation. On the other hand, the measurement of the mean bead displacements allowed determining retraction forces of filopodia at various retraction speeds. We measured F-actin dependent 36-nanometer steps inside living cells during filopodia retraction likely belonging to actin-based molecular motors [1]. Steps remained clearly visible even at force regimes clearly beyond the stall force of a single myosin motor. This seems to indicate a kind of inter-motor coupling, a phenomenon which we try to explain by a stochastic multi-state model.

[1] Kress, H., E.H.K. Stelzer, D. Holzer, F. Buss, G. Griffiths, and A. Rohrbach: "Filopodia act as phagocytic tentacles and pull with discrete steps and a load-dependent velocity", Proc. Nat. Acad. Sci., Vol.104, 2007, 11633–11638