

Supplementary Video 1 Brightfield video (25 Hz, displayed at normal speed) for a freely rotating tethered GFP-MotB cell and fixed cell in the same field of view.

Supplementary Video 2 Continuous TIRF (1 Hz, displayed at 0.5x normal speed) bleach of cells in Supplementary Video 1.

Supplementary Videos 3, 4 Continuous TIRF illumination (10 Hz, displayed at normal speed) on a different pre-bleached fixed GFP-MotB cells showing diffusing GFP-MotB in the membrane.

Supplementary Video 5 Brightfield video (25 Hz, displayed at normal speed) for a freely rotating tethered GFP-MotB cell.

Supplementary Video 6 Continuous TIRF bleach (1 Hz, displayed at normal speed) of cell in Supplementary Video 3.

Supplementary Video 7 Continuous TIRF bleach (1 Hz, displayed at 0.5x normal speed) of cell in Supplementary Video 4, 60 min after the end of the initial bleach.