**Supplementary documents**

- **VideoS1.avi**

Movie of the constriction area when the symmetry breaking is established and then the flow is reversed. One can see the building of the symmetry breaking on the other side

- **FigureS1**

Time evolution of the symmetry breaking parameter $SB(t)$ at $\langle V_x \rangle = 20 \mu m/s$ as the flux direction is suddenly reversed from left to right (triangles) and then right to left (circle); $t=0$ represents the onsets of flow inversion; see arrows pointing in the flow direction. Points and continuous lines correspond respectively to experimental values and adjacent-average smoothing.
Movie of an area around the left lateral wall far from the constriction illustrating the adsorption and desorption processes.

- **VideoS2.avi**

Backflow motion of bacteria trapped at the side wall. (a) Snapshot of the movie (Video2_add.avi) featuring in red, a pixel line from which the spatio-temporal diagram of (b) is constructed. (b) Spatio temporal diagram showing characteristic streaks witnessing a backward motion at the side walls.