Electronic Supplementary Material (ESI) for Lab on a Chip.

Support information

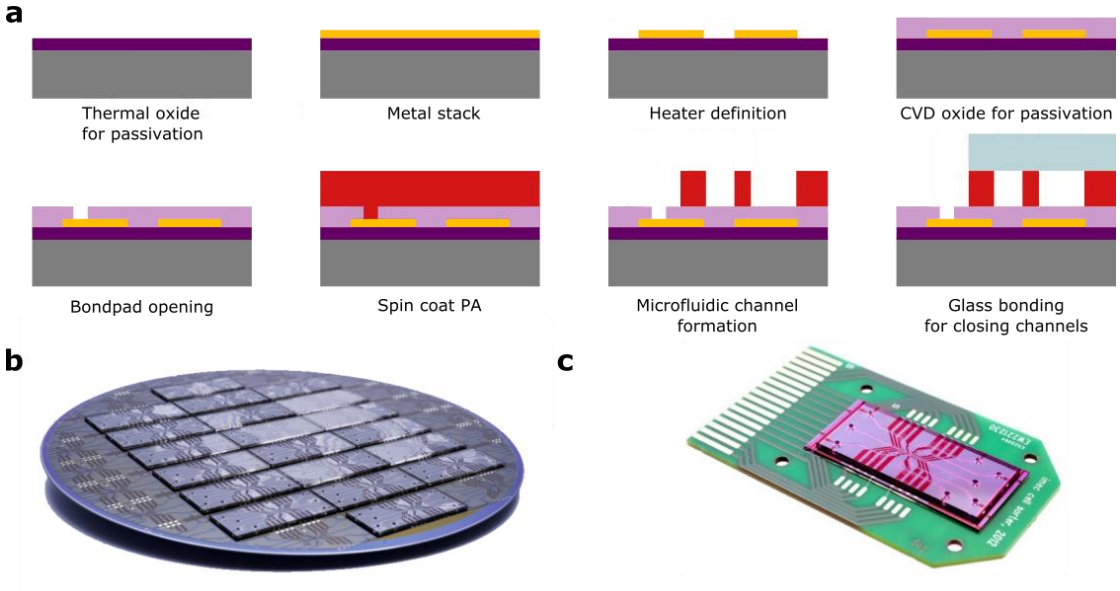

Figure S1. Cell sorter fabrication flow. (a) Fabrication steps of cell sorter chip with integrated fluidics and jet flow generator. (b) Photograph of 200 mm cell sorter wafer before dicing. Glass dies are attached to the cell sorter dies on wafer level. (c) Photograph of cell sorter chip packaged and wire-bonded to PCB.

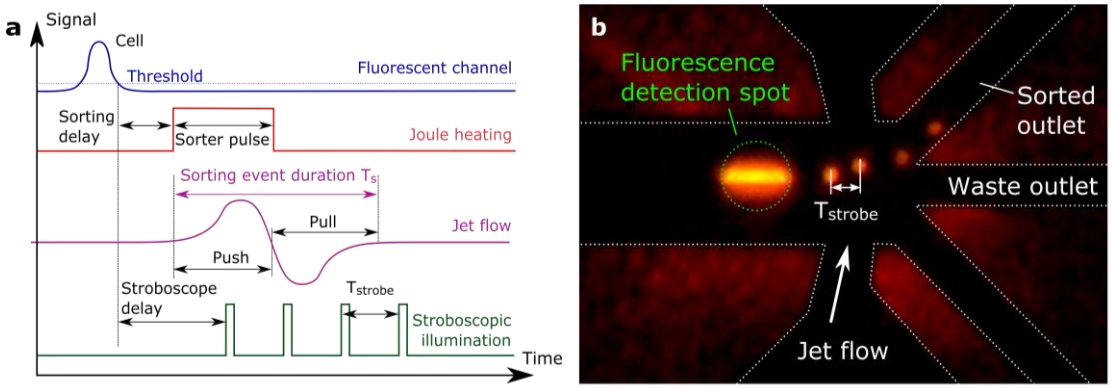

Figure S2. Jet flow sorting process. (a) Timing diagram of jet flow sorting process. If a passing cell generates a peak above threshold, the sorter is actuated with a Joule heating pulse after a certain delay of the falling edge of the pulse. Almost immediately the vapor bubbles start to emerge and create a push jet flow capable of sorting a passing cell. When the pulse has ended, the vapor bubbles shrink and collapse creating a pull jet flow. The total sorting event duration (T_s) consists of the push and pull flow. For some experiments, a train of stroboscopic pulses is used to trigger the nanosecond laser or LED to illuminate the cell track or reverse dye flow respectively during a sorting event. (b) Tracking of a single sorted cell during jet flow sorter process. After cell detection, a train of stroboscopic flashes from the nanosecond laser illuminates the cell's track with a certain strobe period (T_{strobe}). This setup is used to optimize the delay between Joule heating actuation pulse and cell passage.

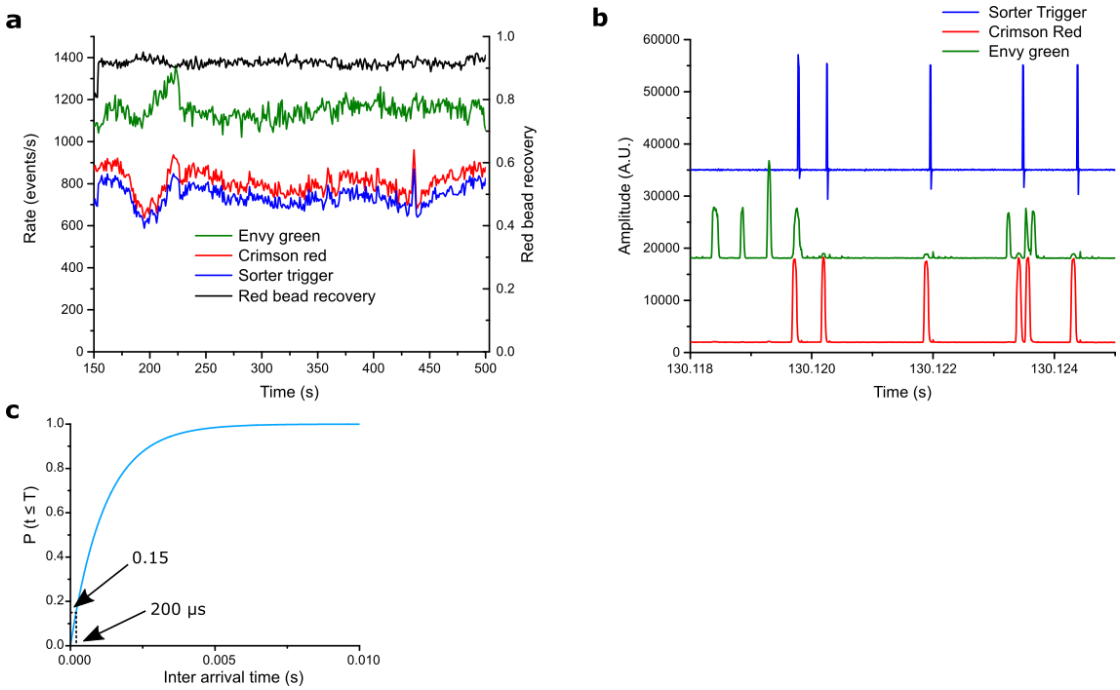

Figure S3. Investigation of purity and recovery of experiment 4. (a) The red and green bead throughput as well as the sorter firing rate during experiment 4. The sorting firing rate followed the red bead rate, recovering more than 90% percent of detected red beads. (b) Snapshot of time diagram with sorter trigger peaks and red and green bead signals. Typical coincidences of red with green beads and red with bead coincidences are visible, lowering purity and recovery respectively. (c) Cumulative inter arrival time of red beads where the exponential slope rate is extracted from the measured crimson red bead inter arrival time. 15% of red beads coincide within a sorting event period of 200 µs lowering recovery as they are omitted by the sorter.

Table S1. MCF-7 cells spiking in PBMC's extended results.

Test	Cell preservation	MCF-7 events video	Tumor cells on sieve
10	Fresh	110	19
11	Fixed	104	31

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Video S1 Micro vapor bubble sorting animation. Cells are focused to the middle of the microfluidic channel. To detect target cells for sorting, the fluorescence of the cells is detected with off-chip optics. After detection of a target cell, a short electrical pulse is activated when the cell arrives at the jet flow generator chamber. This creates many micro vapor bubbles at predefined hotspots at the flower shaped micro heaters. The collective creation of the vapor bubbles generates a short and powerful jet flow that sorts cells to the farther outlet channel. While sorted cells flow into a diverging channel, unsorted cells flow straight ahead to the middle outlet.

Video S2 Fluidic simulation of push and pull jet flow cycle during cell sorting for 50 µs jet flow duration and 0.6 m/s average flow speed from left to right. The resistive heating pulse is 30 µs wide and particle release interval was 7.5 µs (red). Two particles were sorted by the jet flow: the first sorted by the push jet flow to the upper outlet channel and the second sorted by the pull jet flow to the lower outlet channel.

Video S3 High rate fluorescent bead sorting with 4,000 beads/s at 0.8 m/s cell flow speed. The left laser spot detected beads to trigger the sorter and the right laser spot counted correctly sorted cells in the sorted outlet channel.
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