Supplementary Information

Video S1 System validation under low flow speed.

Video S2 Cells separated by the channel.

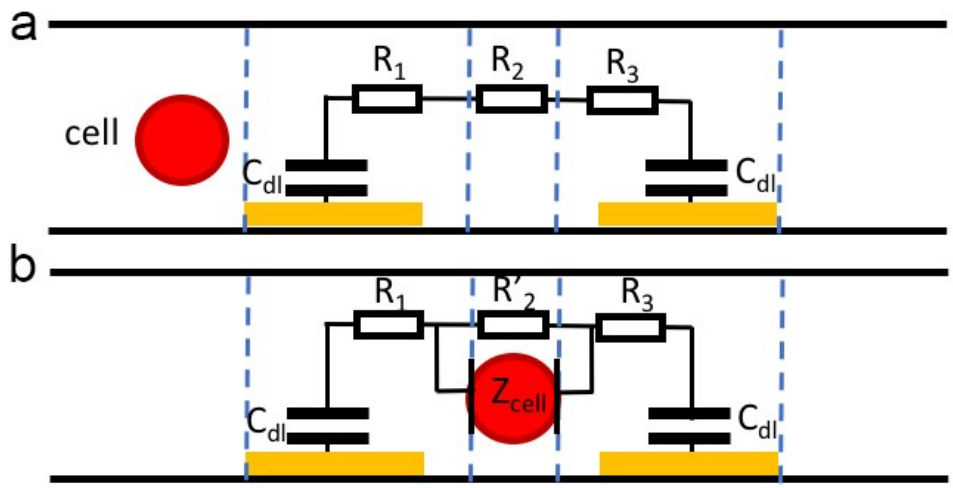

Figure S1 Electric model of the microfluidic channel (a) and a cell pass through the channel (b). C_{dl}, $R_{1\text{-}3}$, and Z_{cell} represent electrode-solution interface capacitance, solution resistance of different parts (R1 and R3, the constriction part of the channel; R2, the narrowest part), and impedance of cell, respectively.

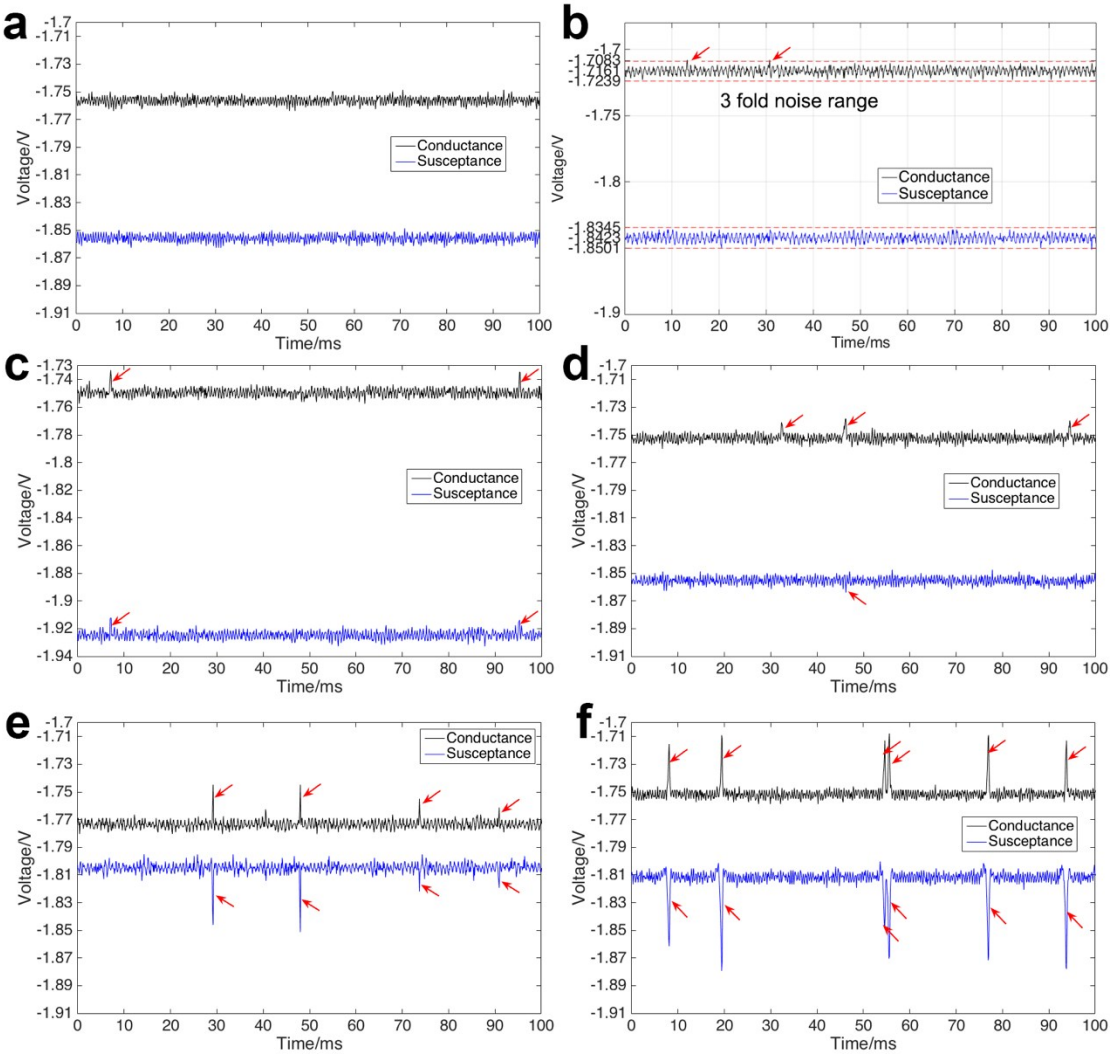

Figure S2. Raw signals of different cells/particles. Red arrows indicate the pulses of the cells/beads (channel height = 12 μm and excitation amplitude = 0.30 V). Impedance signals (conductance and susceptance) without any particles (a), or with Ø5-μm polymer beads (b), Ø10-μm polymer beads (c), necrotic HeLa cells (d), live Jurkat cells (e), and live HeLa cells (f) passing through the detection area.

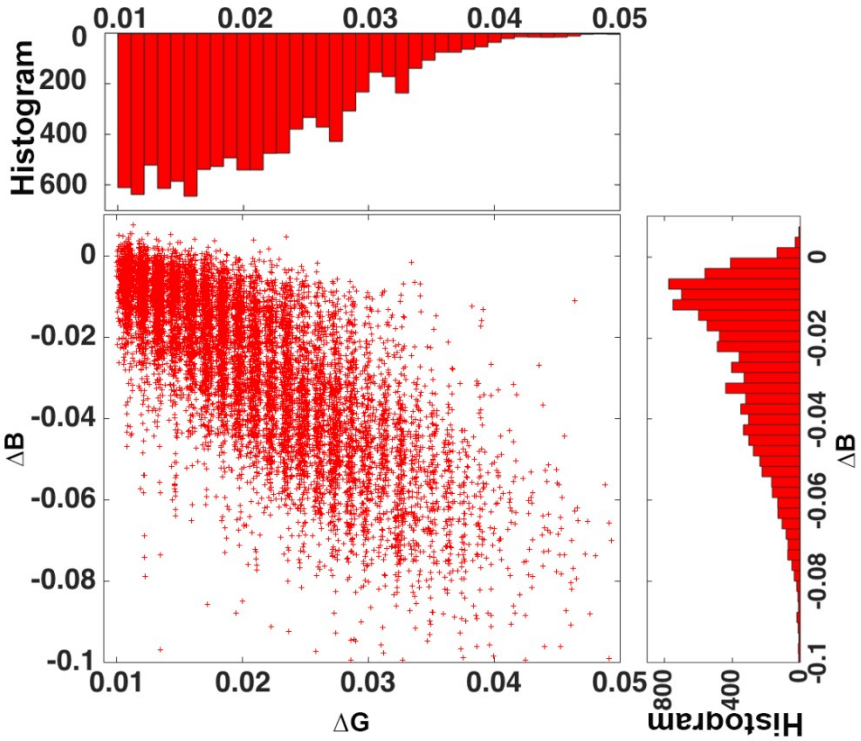

Figure S3. The scatter and histogram plot of Jurkat cells

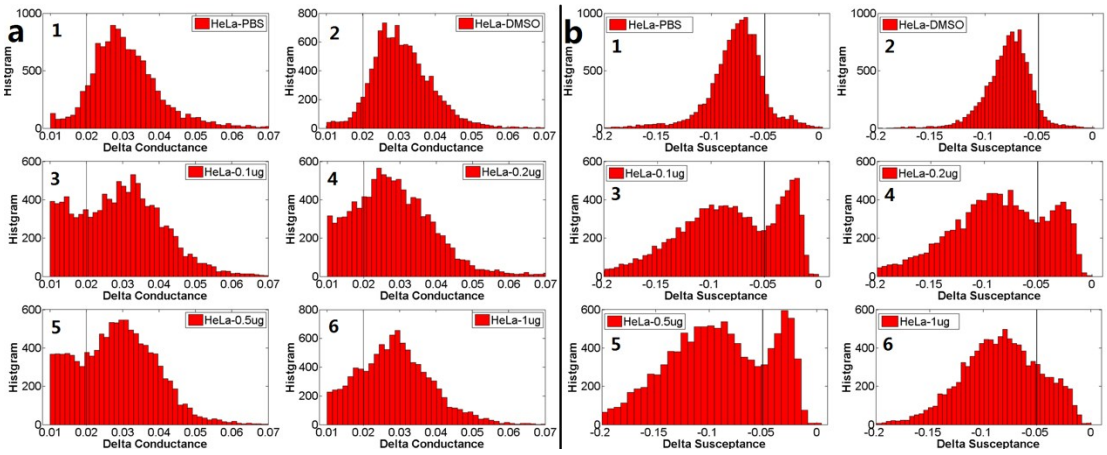

Figure S4. Histograms of six samples. Black lines indicate the threshold for conductance (a) and susceptance (b).

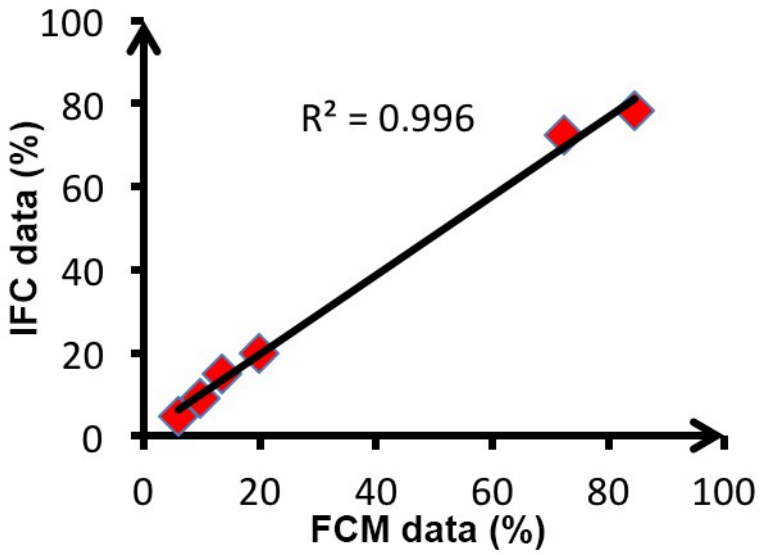

Figure S5. Comparison of viability tests by IFC and traditional FCM.

Table S1. Literature summary of IFC chip researches

Refs.	Impedance technology	Experimental samples	Materials & channel (width × height) & flow velocity	Demonstrated detection rate & statistical number	Focusing methods & hardware
Our methods	Constriction channel with two coplanar electrodes 1MHz	3, 5,7 and 10 μm microsheres Hela, Jurket cell lines	PDMS 25 × 12 μm² 100 mm/s	172 cells/s 10000 events	No focusing Lab-build lock-in amplifier
Cheung et al. (2005) Cytometry A 65A:124–132	Wheatstone bridge 350 kHz to 20 MHz	4, 5.14 and 6 μm polysyrene beads RBCs, fixed RBCs, ghosts	Polyimide 40 × 20 μm² 10 mm/s	16.7 cells/s 800 events	nDEP forces SR-844, Stanford Research Systems
Benazzi et al. (2007) IET Nanobiotechnol 1:94–101	Wheatstone bridge 327kHz and 6.03MHz	Phytoplankton (Isochrysis Galbana, Rhodosorus m., Synechococcus sp.)	Polyimide 11 × 20 μm² 39 mm/s	100 cells/s 2500 events	No focusing SR-844, Stanford Research Systems
Rodriguez-	Impedance	20 μm beads	PDMS	20 beads/s	Two/three sheath

Trujillo et al. (2008) Biosens Bioelectron 24:290–296	analyser		190 × 50 μm^2 < 5.3 mm/s	< 200 events	flow
	120 kHz and 1 MHz				Agilent 4294A
Wang et al. (2008) Lab chip 8:309-315	MOSFET drain current	CD4+ T cells	PDMS 16 × 30 μm^2 NA	8 cells/s 1166 events	No focusing
	DC				SR 850, Stanford Research Systems
Holmes et al. (2009) Lab Chip 9:2881–2889. (2010) Anal Chem 82:1455–1461	Parallel facing electrodes	Protein coated 5.6 μm microspheres, whole blood, CD4 T-Lymphocytes	Polyimide 20 × 20 μm^2 60 mm/s	100 cells/s 5000 events	nDEP forces
	500 kHz to 30 MHz				SR 844, Stanford Research Systems
Bernabini et al (2011) Lab Chip 11:407-412	Parallel facing electrodes	1, 2μm polystyrene beads and *E coli.*	Polyimide 200 × 30 μm^2 38 mm/s	100 cells/s 3000-5000 events	hydrodynamic focusing by oil
	503 kHz and 5 MHz				SR 844, Stanford Research Systems
Chen et al. (2011) Lab Chip 11: 3174-3181. (2011) Biomicrofluidics, 5:014113	Constriction channel with external Ag/AgCl electrodes	MC-3T3 (osteoblasts), MLO-Y4 (osteocytes), EMT6, EMT6/AR1.0	PDMS 6 × 6 μm^2 8 × 8 μm^2 NA mm/s	<2 cells/s 770 events	No focusing
	10 kHz and 100 kHz				Agilent-4294A Impedance Analyzer
Song et al. (2013) Lab Chip 13: 2300-2310.	Constriction channel	20 μm polystyrene beads, P19 stem cells	PDMS 40 × 27 μm^2 3 mm/s	< 2 cells/s 200 events	No focusing
	50 kHz, 250 kHz, 500 kHz and 1 MHz				HF21S, Zurich Instruments
Hassan et al. (2014) Lab Chip 14:1469-1476. (2014) Lab Chip 14:4370-4381	Three coplanar electrodes in constriction channel	Lymphocytes, granulocytes, monocytes	PDMS 15× 15 μm^2 4400 mm/s	50 cells/s ~ 3000 events	No focusing
	303 kHz				HF21, Zurich Instruments
Nguyen et al. (2015) Lab Chip 15:1533-1544	external Ag/AgCl electrodes	6.2-8.2 μm RBC, 10-15 μm WBC	PDMS 15× 15 μm^2 NA mm/s	~8.3 cells/s ~ 10000events	No focusing
	10, 100, 400, 990 kHz				NA
Watkins et al. (2011) Lab Chip 11:1437-	Three coplanar electrodes in constriction	7.32 mm polystyrene beads, CD4+	PDMS 15× 15 μm^2 2200 mm/s	2236 cells/s 26054 events	No focusing

1447.	channel	and CD8+ T lymphocytes			
	303 kHz, 1.1 MHz and 1.7 MHz				HF21, Zurich Instruments

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