The importance of travelling wave components in standing surface acoustic wave (SSAW) systems†

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I. Supplementary Information (SI)

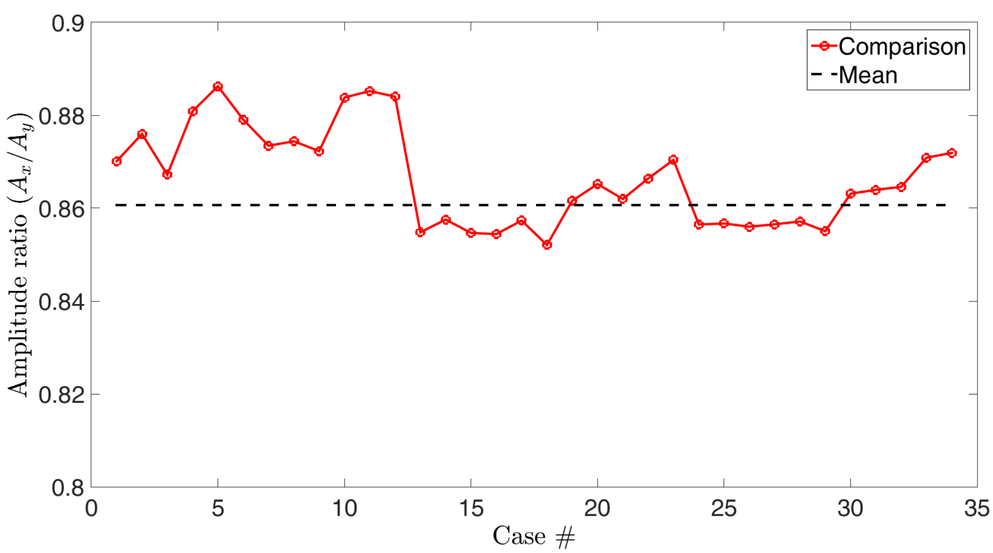

Fig. S1: *Plots depicting the amplitude ratio A_x/A_y (Mean value determined for all SSAW (i.e. 2 terminal) cases considered; i.e. Case 14 to 34) for a range of travelling wave and standing wave scenarios determined via curve fitting when compared to a fully coupled LN-fluid system along with the mean value as used in the numerical results. Reference to parameters and dimensions used for each case is listed in Table S1.*

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Table S1: *Case parameters as per produced in Figure S1. Number of interdigital transducer (IDT) terminals denote a travelling wave (TSAW) (i.e. 1) or a standing wave (SSAW) (i.e. 2) scenario. A h/λ_{SAW} = 1/4.8 was used to compare the streaming fields with that reported by Nama et al.*[1] *(i.e. $W = \lambda_{SAW}$, h = 1/4.8; λ_{SAW} = 600 μm). All cases are based on a λ_{SAW} = 40 μm.*

Case Number (#)	BC_{imp}	Number of IDT terminals	W/λ_{SAW}	h/λ_{SAW}
1	PDMS	1 (TSAW)	10	1/4.8
2	PDMS	1 (TSAW)	10	1
3	PDMS	1 (TSAW)	10	2.5
4	PDMS	1 (TSAW)	5	1/4.8
5	PDMS	1 (TSAW)	5	1
6	PDMS	1 (TSAW)	5	2.5
7	Water	1 (TSAW)	10	1/4.8
8	Water	1 (TSAW)	10	1
9	Water	1 (TSAW)	10	2.5
10	Water	1 (TSAW)	5	1/4.8
11	Water	1 (TSAW)	5	1
12	Water	1 (TSAW)	5	2.5
13	PDMS	2 (SSAW)	10	1/4.8
14	PDMS	2 (SSAW)	10	1
15	PDMS	2 (SSAW)	10	2.5
16	PDMS	2 (SSAW)	5	1/4.8
17	PDMS	2 (SSAW)	5	1
18	PDMS	2 (SSAW)	5	2.5
19	PDMS	2 (SSAW)	2	1/4.8
20	PDMS	2 (SSAW)	2	1
21	PDMS	2 (SSAW)	2	2.5
22	PDMS	2 (SSAW)	1	1/4.8
23	PDMS	2 (SSAW)	1	1
24	Water	2 (SSAW)	10	1/4.8
25	Water	2 (SSAW)	10	1
26	Water	2 (SSAW)	10	2.5
27	Water	2 (SSAW)	5	1/4.8
28	Water	2 (SSAW)	5	1
29	Water	2 (SSAW)	5	2.5
30	Water	2 (SSAW)	2	1/4.8
31	Water	2 (SSAW)	2	1
32	Water	2 (SSAW)	2	2.5
33	Water	2 (SSAW)	1	1/4.8
34	Water	2 (SSAW)	1	1

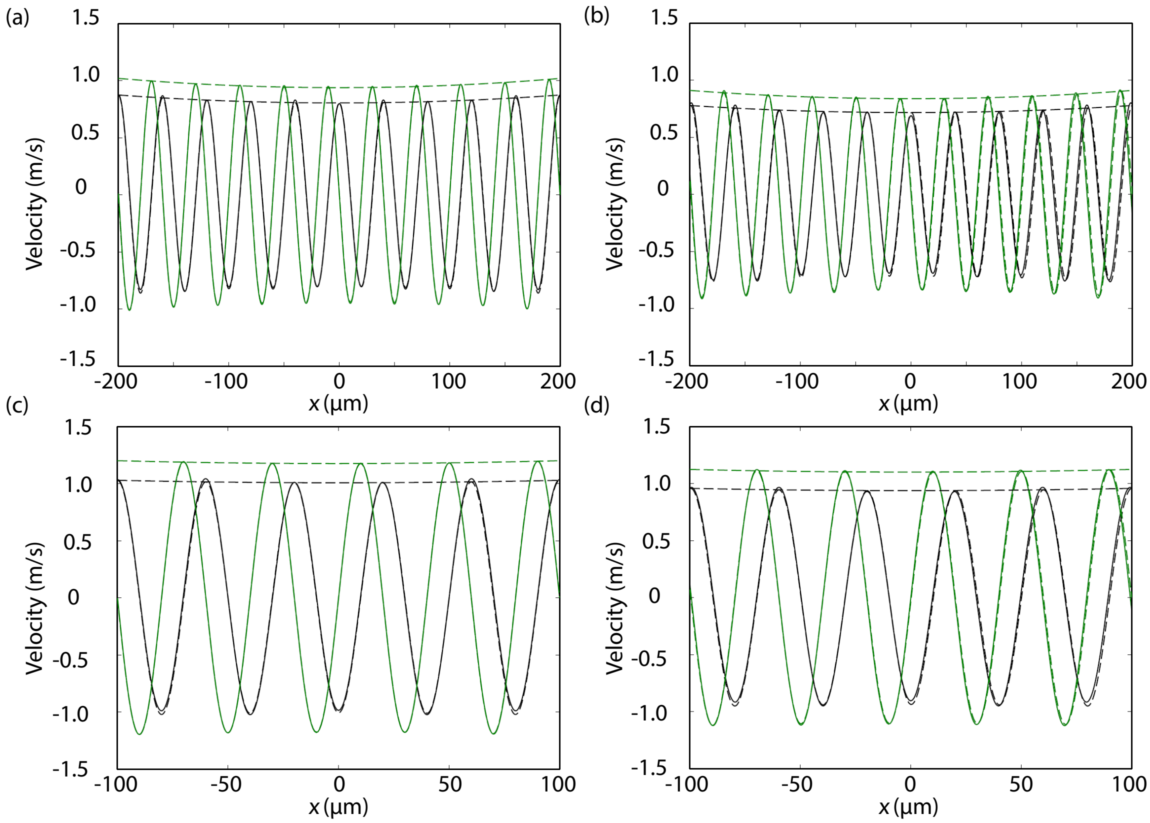

Fig. S2: *Plots depicting four specific cases showing the comparison between a fully coupled LN-fluid system against the use of the boundary condition in Equation 16 of the velocity at the LN-fluid interface. Comparisons for a SSAW case with W = 200 µm (i.e. 10 λ_{SAW}) (a) h = 40 µm (i.e. 1 λ_{SAW}; Case Number 14) (b) h = 100 µm (i.e. 2.5 λ_{SAW}; Case Number 15) and with a W = 100 µm (i.e. 5 λ_{SAW}) (c) h = 40 µm (i.e. 1 λ_{SAW}; Case Number 17) (d) h = 100 µm (i.e. 2.5 λ_{SAW}; Case Number 18). The y component velocity u_y, is denoted by the green line and the x component velocity u_x, is denoted by the black line. Solid lines represent the fully coupled model results and the dashed lines represent the fitted data along with the decay C_d, denoted on top of each curve.*

Note: Reference to parameters and dimensions used for each case is listed in Table S1.

References

[1] N. Nama, R. Barnkob, Z. Mao, C. J. Kähler, F. Costanzo and T. J. Huang, *Lab on a Chip*, 2015, **15**, 2700–2709.

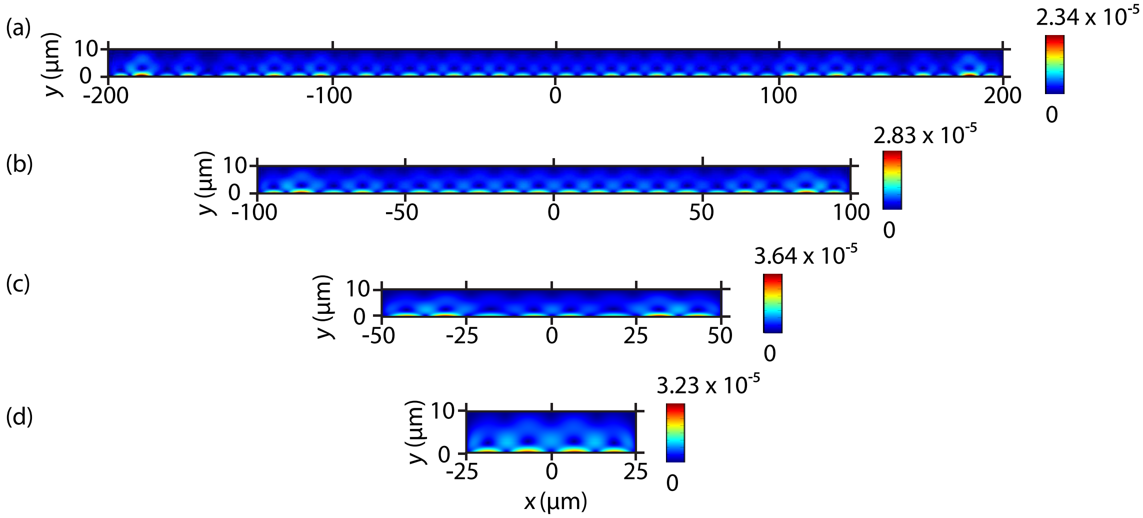

Fig. S3: *Resultant plots for a $\lambda_{SAW} = 40$ µm and 10 µm high (i.e. h= 10 µm; 0.25 λ_{SAW}) with a PDMS impedance boundary condition on the side walls and upper boundary. Surface plots represent the streaming velocity field $\langle v_2 \rangle$ for varying channel widths, (a) W = 400 µm (i.e. $W = 10\ \lambda_{SAW}$),(b)W = 200 µm (i.e. $W = 5\ \lambda_{SAW}$),(c) W = 80 µm (i.e. $W = 2\ \lambda_{SAW}$) and (d) W = 40 µm (i.e. $W = \lambda_{SAW}$)*

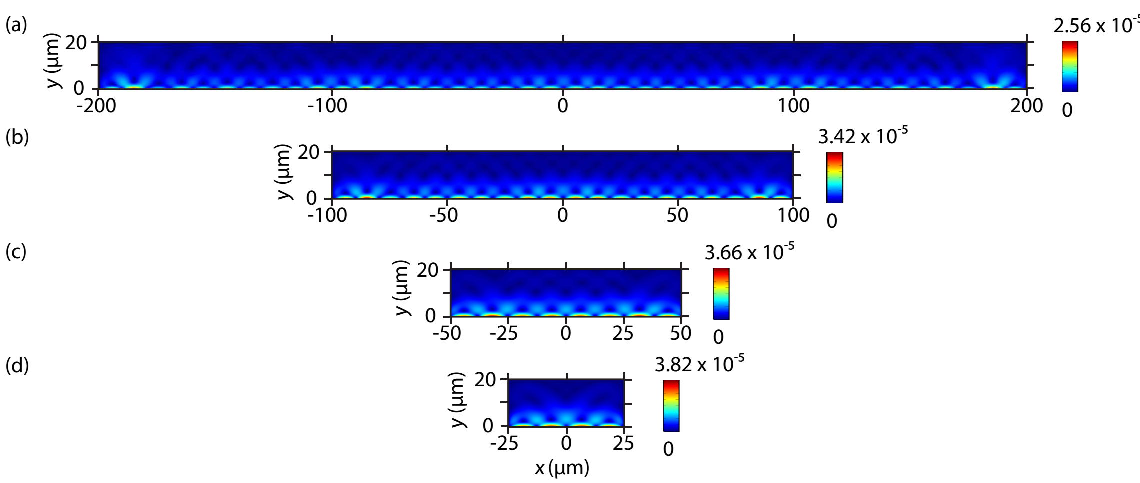

Fig. S4: *Resultant plots for a $\lambda_{SAW} = 40$ µm and 20 µm high (i.e. h= 20 µm; 0.5 λ_{SAW}) with a PDMS impedance boundary condition on the side walls and upper boundary. Surface plots represent the streaming velocity field $\langle v_2 \rangle$ for varying channel widths, (a) W = 400 µm (i.e. $W = 10\ \lambda_{SAW}$),(b)W = 200 µm (i.e. $W = 5\ \lambda_{SAW}$),(c) W = 80 µm (i.e. $W = 2\ \lambda_{SAW}$) and (d) W = 40 µm (i.e. $W = \lambda_{SAW}$)*

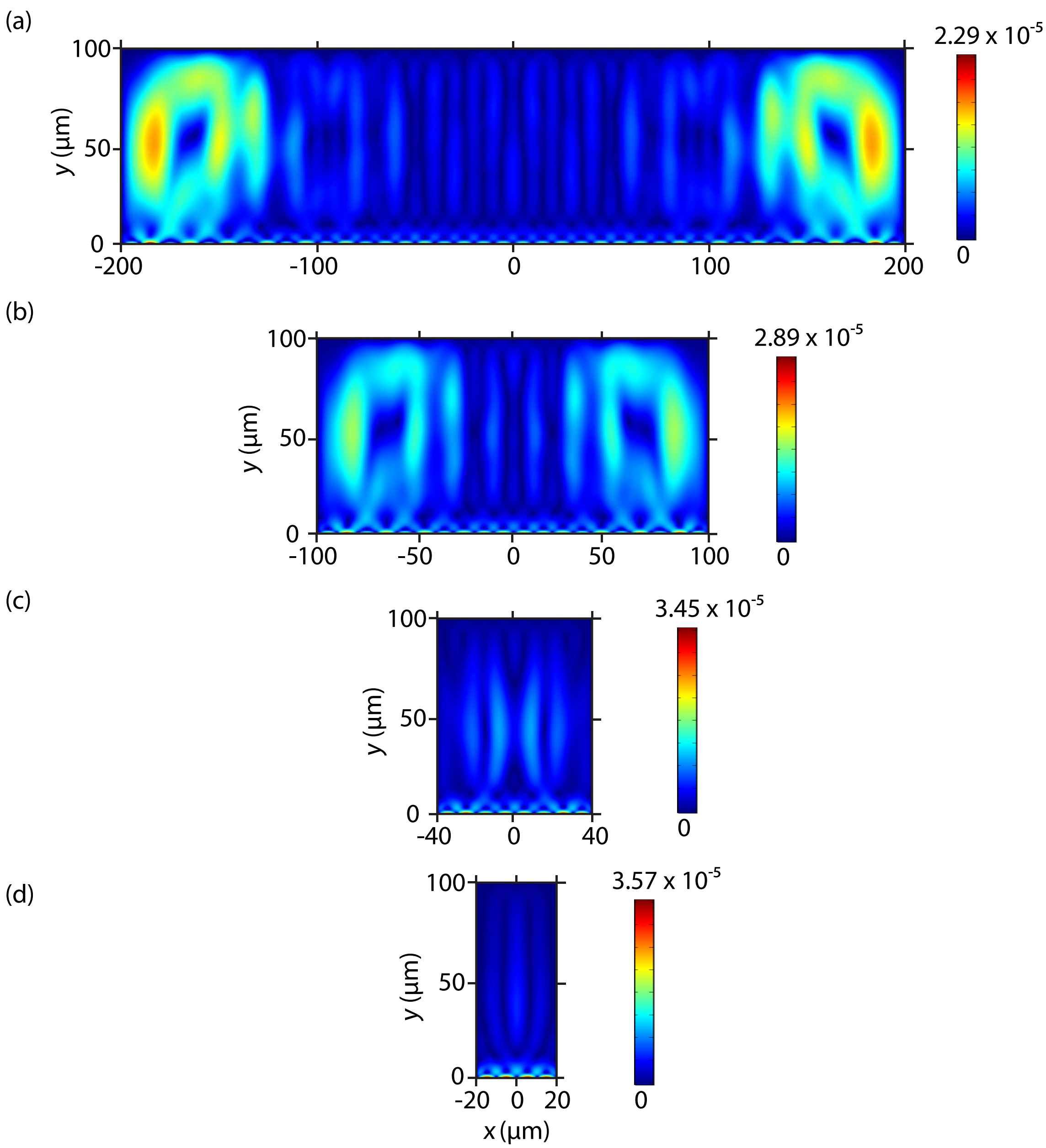

Fig. S5: *Resultant plots for a $\lambda_{SAW} = 40$ µm and 100 µm high (i.e. h= 100 µm; 2.5 λ_{SAW}) with a PDMS impedance boundary condition on the side walls and upper boundary. Surface plots represent the streaming velocity field $\langle v_2 \rangle$ for varying channel widths, (a) W = 400 µm (i.e. W = 10 λ_{SAW}),(b)W = 200 µm (i.e. W = 5 λ_{SAW}),(c) W = 80 µm (i.e. W = 2 λ_{SAW}) and (d) W = 40 µm (i.e. W = λ_{SAW})*

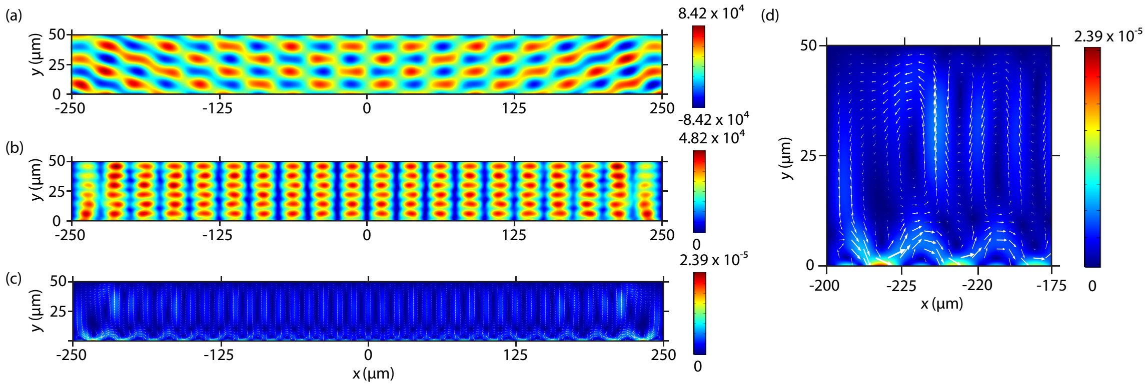

Fig. S6: *Resultant plots for a $\lambda_{SAW} = 50$ µm, 50 µm high and 500 µm wide chamber (i.e. W= 500 µm and h= 50 µm) with a PDMS impedance boundary condition on the side walls and upper boundary. Surface plots represent the (a) first-order pressure fields, P_1 (b) time-averaged second-order pressure fields, $\langle P_2 \rangle$ and (c) streaming velocity field $\langle v_2 \rangle$ and (d) a zoomed in surface plots of the resultant streaming velocity field, $\langle v_2 \rangle$ at the left hand side of the channel to illustrate the observed streaming rolls. Velocity field vectors are depicted with white arrows.*

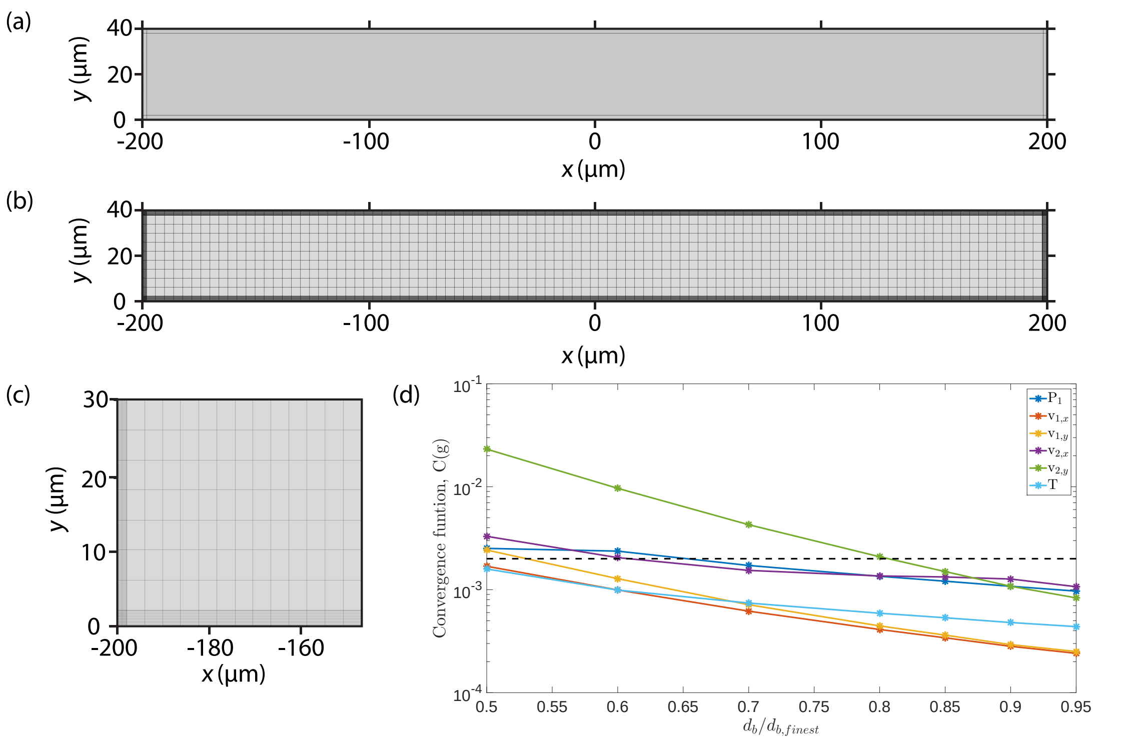

Fig. S7: *Mesh distribution for a 400 µm wide and 40 µm high channel (i.e. W = 400 µm; h = 40 µm), (a) depicting the sectioning done consisting of a 2 µm wide section at each side of the rectangular chamber, (b) an example mesh distribution consisting of boundary mesh elements, d_b= 4 µm × 0.2 µm and (c) a zoomed in view of the bottom left corner of the rectangular geometry. (d) Mesh convergence analysis carried out to satisfy a convergence, $C(g)$ = 0.002 (Depicted with a black dashed line).*

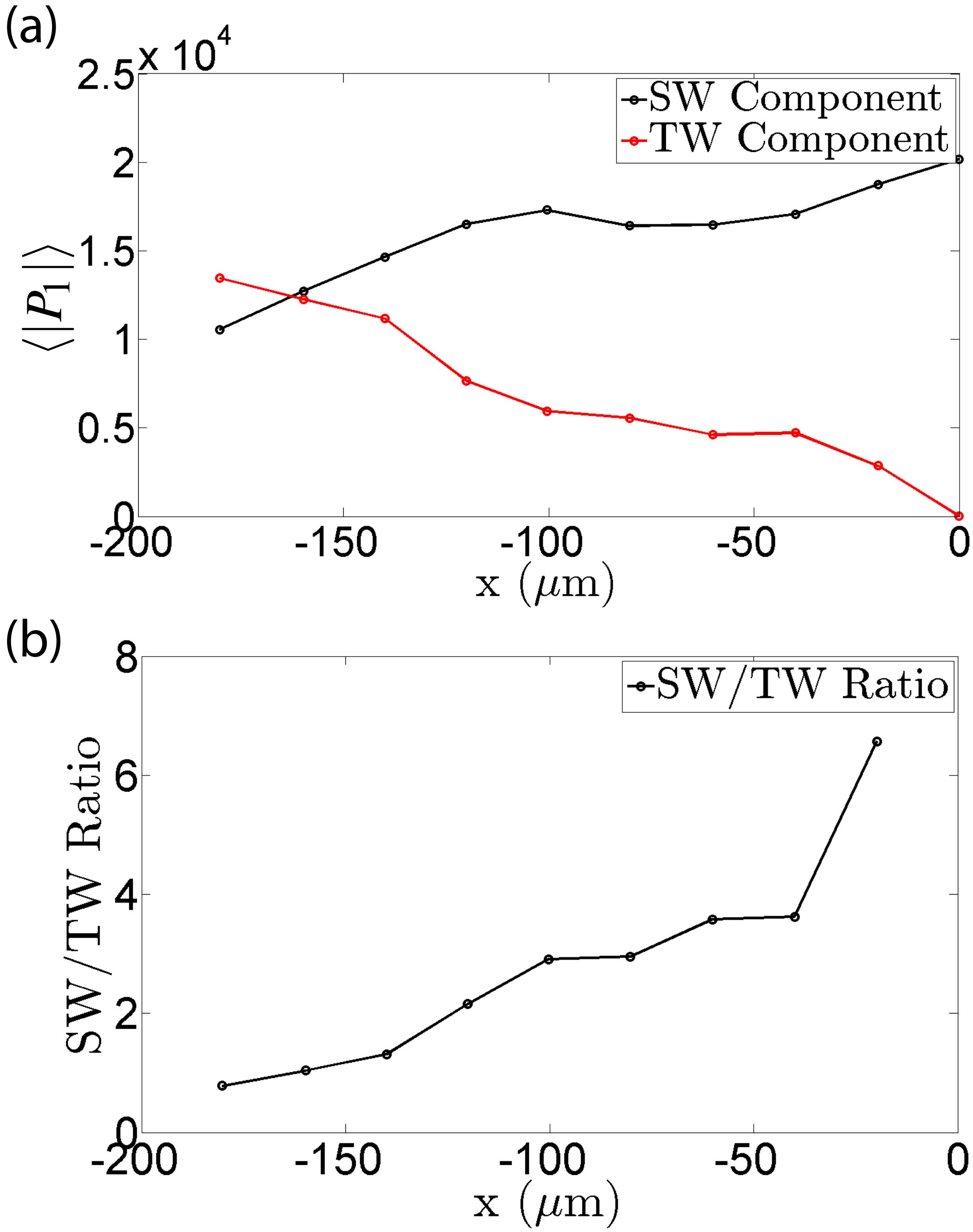

Fig. S8: *Line plots describing the TW to SW ratio at y = 5 μm, where (a) the time-averaged absolute pressure,* $\langle|P_1|\rangle$ *against position x of the TW and SW components individually in μm (b) The SW to TW ratio at the local pressure minima locations in the x-direction.*
Note: All demonstrated values correspond the left half of the channel width (i.e. x= -200 μm : 0 μm) and are symmetrical about x= 0 μm . The SW/TW ratio is not shown for the node in the centre of the channel (i.e. x = 0 μm) as it would skew the other values, registering a SW/TW ratio of 1.4987×10^{12}.