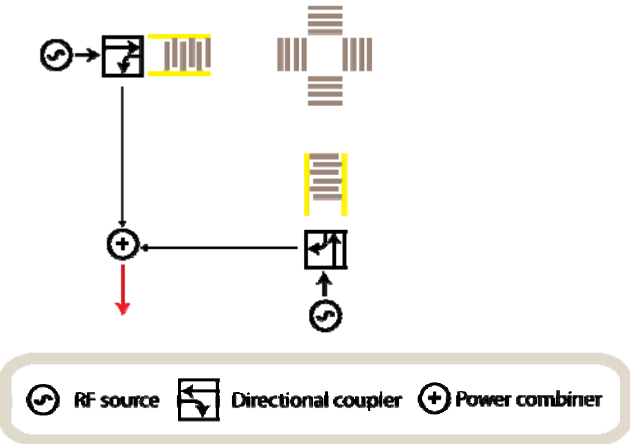

Fig. S1 Schemes for SAW integrated droplet OR/AND ports depending on the power threshold set at the output (red line).

Table S2 Behavior of the OR port in Fig S1. The inputs are the droplets positions in (input value 1) or out (input value 0) of the cavity and the output is the electrical power read after the power combiner with a threshold equal to the reflected signal by one of the two IDT.

Droplet 1	0	1	0	1
Droplet 2	0	0	1	1
Output OR	**0**	**1**	**1**	**1**

Table S3 Behavior of the AND port in Fig 4. The inputs are the droplets positions in (1) or out (0) of the corresponding target position and the output is the electrical power flowing out the directional coupler of the second delay line

Droplet 1	0	1	0	1
Droplet 2	0	0	1	1
Output AND	**0**	**0**	**0**	**1**

The phenomenon of resonant coupling between travelling SAW waves and a resonator exploited in this work for automatic passive fluid positioning allows the possibility of automatically routing fluids and build logic ports based on the instantaneous fluid distribution as shown here. Fig. S1 shows a scheme for realizing an OR port: this is obtained patterning two perpendicular delay lines each coupled with a cavity. The center position of both cavities is the same. Each IDT is connected to a corresponding RF source. A directional coupler placed between sources and IDTs allows recollecting the reflected signals. These are sent to a power combiner providing the output of the port through the sum of them. The output power is equal to zero when no droplet is present in the resonators. Otherwise, it is respectively equal to the one or two times the IDT feeding signal when only one or both droplet have been delivered in the cavity. Setting the 0/1 logic threshold at a power level less or equal to the IDT feeding power we obtain the logic table shown in Table S2, which correspond to an OR logic gate.

The same scheme realizes also an AND gate setting the 0/1 logic threshold at a power comprised between one and two in IDT feeding power units. This results in the logic table shown in Table S3. Within this scheme, 1 logic value as an output of the AND port corresponds to the merging of the droplets.

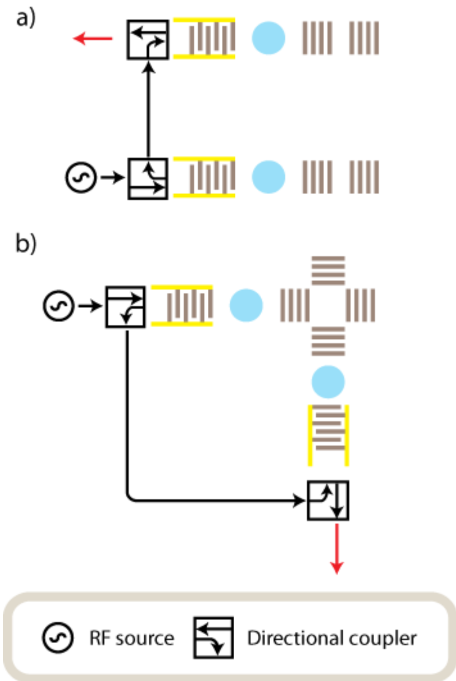

Fig. S4 Schemes for sequential single RF source SAW integrated droplet AND ports. Red line represents the electrical output of the port. Scheme a) has separated droplets at the output, while scheme b) present a merging of the inputs at the fluidic output.

The AND port can be realized also as shown in Fig. S4. This scheme implements a sequential routing of multiple (two in the figure) droplets to target positions. It requires only a single RF source. The output of these ports is the power reflected by the last cavity. This is non-zero only in the case that all the target positions are reached, because only in this case the RF signal is reflected by each cavity and redirected by directional couplers to the subsequent IDT, hence the output of these port follows the logic table of the AND port as shown in Table S3. The scheme proposed in Fig. S4 a) has the unique characteristic that, when output is equal to 1, the droplets are not merged: this is of particular interest for clocking parallel fluid operations on distinct objects.

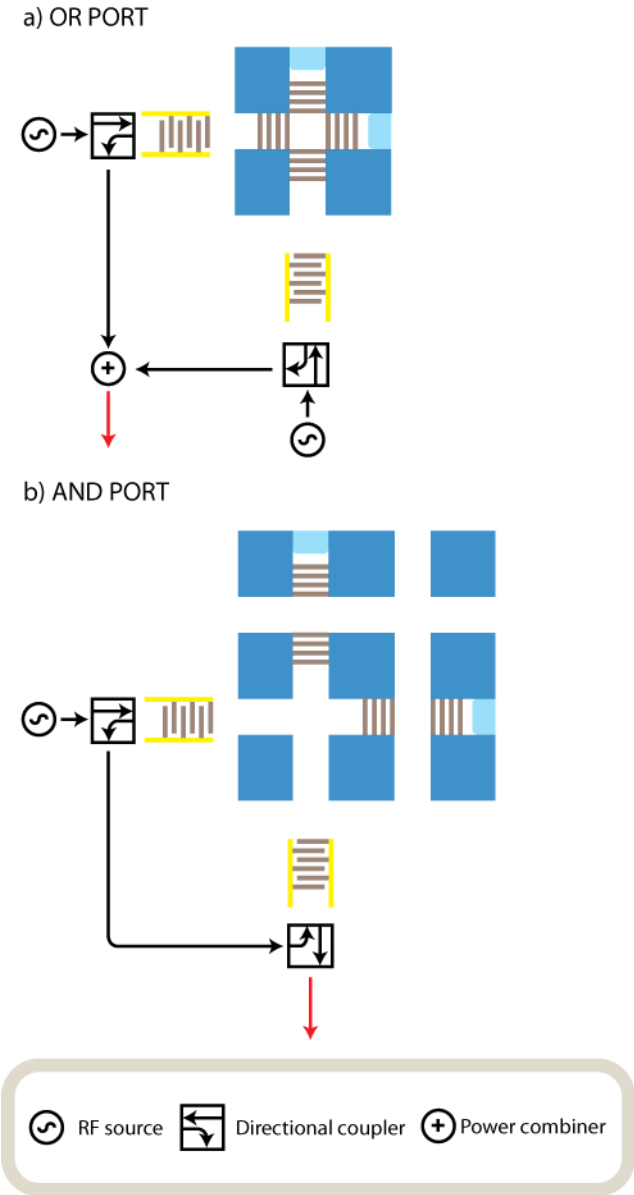

Fig. S5 Scheme of SAW integrated microfluidic logic port for closed channels geometry exploiting acoustic counterflow actuation. Unlike in the droplet case, AND port with merging inputs at the output could not be realized without a precise clocking of the filling dynamics because acoustic counterflow is based on a filling dynamics in opposite direction of SAW that is damped as soon as one of the liquid fills the cavity.

In Fig. 5 we show possible schemes for the OR and AND ports compatible with closed microchannels: the design is based on the same arguments used before for droplet and accounting for the fact that in closed channel the most effective pumping scheme of liquid with SAW is acoustic counterflow that implies that the travelling SAW propagates in the opposite direction of the fluid filling the channel[3]. Here the SAW pulls the liquid from the reservoir into the channel[3], therefore the cavity must be placed between the IDT and the reservoir. At resonance, the SAW is transmitted through the resonator and pumps the liquid into the channel. Again, when the fluid reaches the cavity, it destroys the resonance and the SAW is reflected back to the IDT. In this situation the interactions between the acoustic field and the liquid are strongly suppressed and the liquid stays in the cavity.

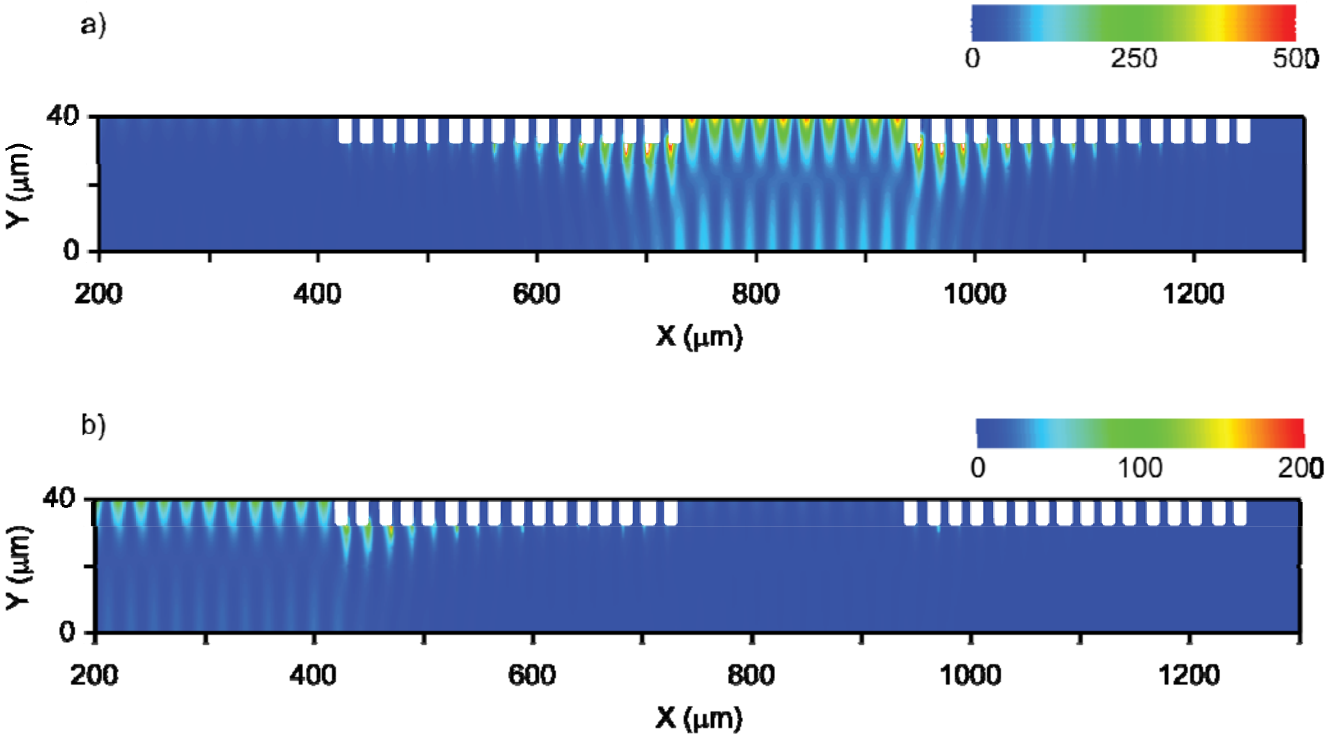

Fig. S6 Mechanical energy density distribution in FEM simulation of the device described in the paper at 95.52 MHz in the case no absorber is placed in the cavity fulfilling the resonance condition (Panel a) and in the case an absorber is placed within the cavity (Panel b), destroying the resonance condition so that the IDT power is strongly reflected by the resonator. This absorber, that has the same elasticity matrix of lithium niobate but with a loss factor of η_s=0.03, has been placed in the center of the cavity and occupies 180 μm of the 200 μm between the mirrors for a depth of 80 μm, twice the SAW wavelength.