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Characterization of the Trilobite Hydrodynamic Particle Separation Microchip with μPIV

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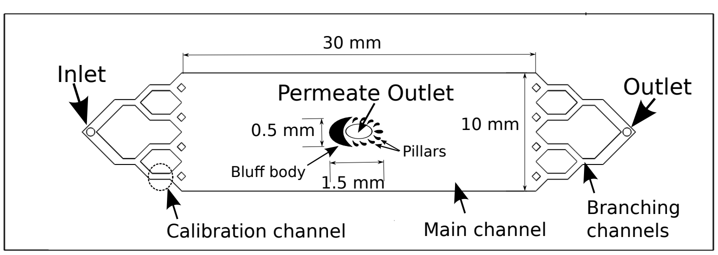
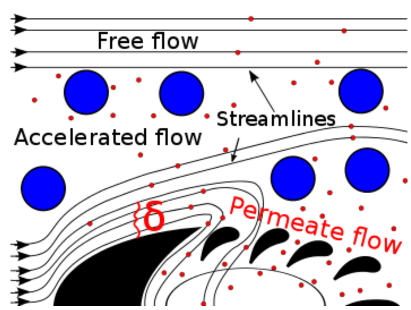
ABSTRACT

The hydrodynamic micro particle separator in Figure 1 (a) has been tested by means of streakline visualizations and Particle Image Velocimetry (PIV) for different flow configurations. By adjusting the pressure drop and the Reynolds number, it is possible to determine the thickness δ of a flow layer that ends up as permeate, see Figure 1 (b). The results of the streakline visualizations show that the permeate flow thickness decreases with decreasing pressure drop between the inlet and the permeate outlet. Increasing the Reynolds number has the same effect.

The Trilobite microchip in Figure 1 (a) consists of an inlet, a permeate outlet, and a second outlet downstream interconnected by microfluidic channels. The trilobite shaped separation unit is located in the center of the main channel. It consists of a bluff body, which serves to guide the bulk flow of fluid and particles, turbine blade shaped pillars and a permeate outlet. The pillars serve to guide the permeate flow onto the permeate outlet.



(a) The hydrodynamic particle separation microchip. The trilobite shaped separation unit is located in the center of the channel. Channel height is 90 μm. Inlet and permeate outlet are pressure regulated. The outlet downstream is an atmospheric pressure outlet.
Permeate outlet, pillars and bluff body not to scale.



(b) Working principle of the trilobite shaped separation unit: Large blue particles can be separated from the small particles even when inside δ because they have different inertia.

Figure 1: Illustration and working principle of the microfluidic chip.

An ensemble averaged PIV method was used to extract the velocity fields from the image data. By visual inspection of the velocity vector plots, it was found that the locations of the stagnation points on the separator pillars depend on the Reynolds number. The cutoff size of a particle to be separated from the smaller tracer particles inside δ could be found from the flow field.