To a Fluidic Diode for Biomedical Application

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Introduction: Biomedical micropumps are fabricated to automatically and safely inject insulin to a patient who suffers from diabetes. Valveless micropumps with diffuser/nozzle elements are desirable because of their no moving parts which eliminate the risk of break and weakness.

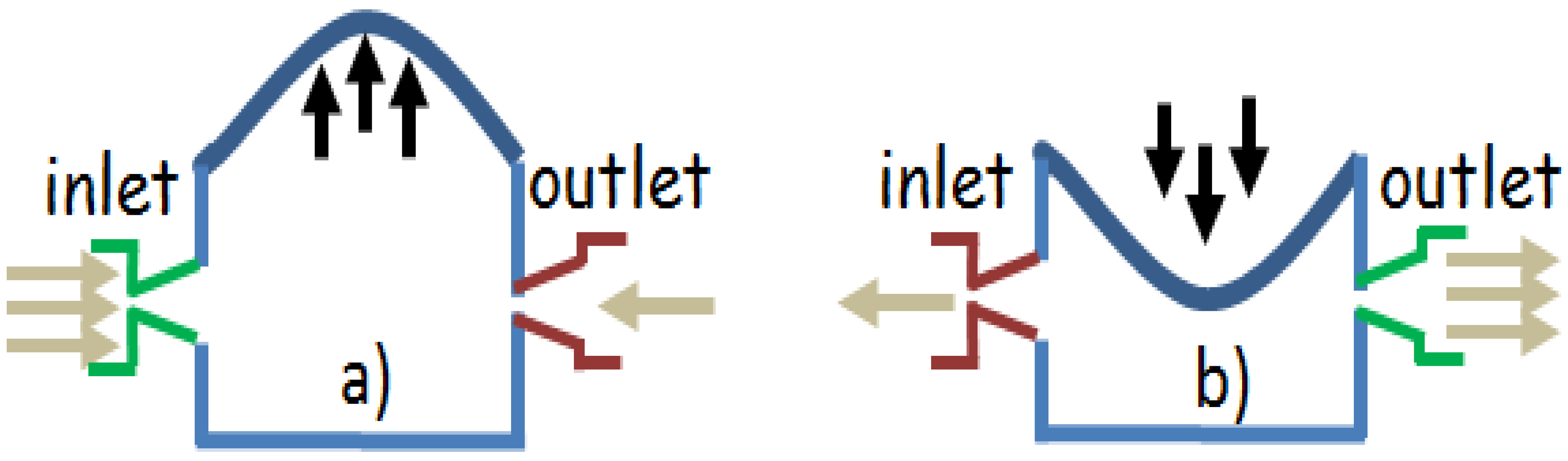

Figure 1. Working principle of micropump
a) Suction mode & b) Pump mode

Valveless micropump is mainly composed of a pumping chamber with diffuser/nozzle elements as inlet and outlet. Firstly (Fig 1.a), the membrane deforms outward and more liquid enters from the inlet than from the outlet. Secondly (Fig 1.b), the membrane deforms inward and the liquid exits from the outlet more than the inlet.

Computational methods: The diffuser/nozzle is modelled and simulated using COMSOL Multiphysics® under the Laminar Flow physics interface. The fluid is considered incompressible.

The goals of the new structure (Fig 2.b) are:

- Increasing the flow rate
- Decelerating the backflow

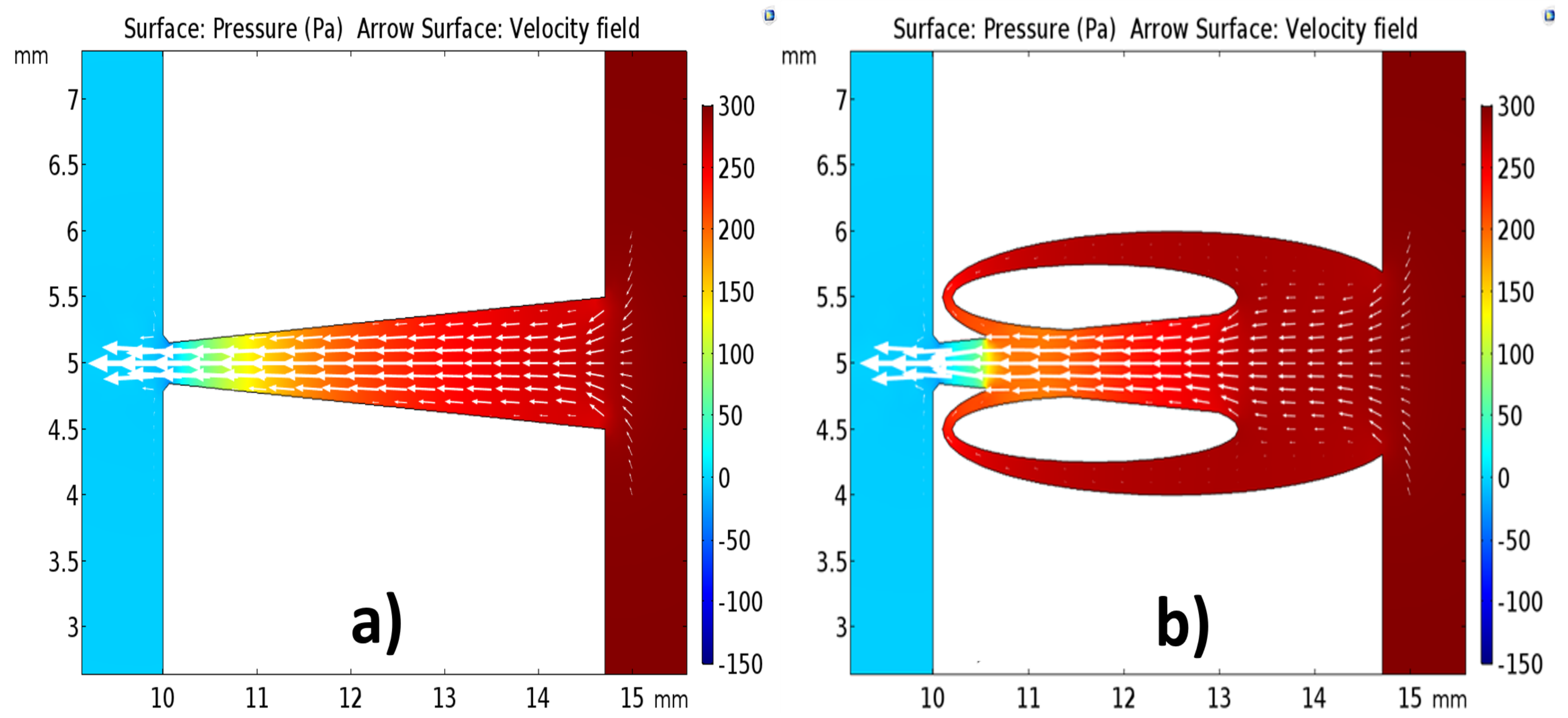

Figure 2. Diffuser/Nozzle structures
a) Simple & b) Enhanced

Therefore, the translation of internal ellipse (Δx & Δy) and the rotation ($\alpha 1$ & $\alpha 2$) of both ellipses need to be modified one by one using parametric sweep (Fig.3). Best modified geometry is used to the next modelling loop.

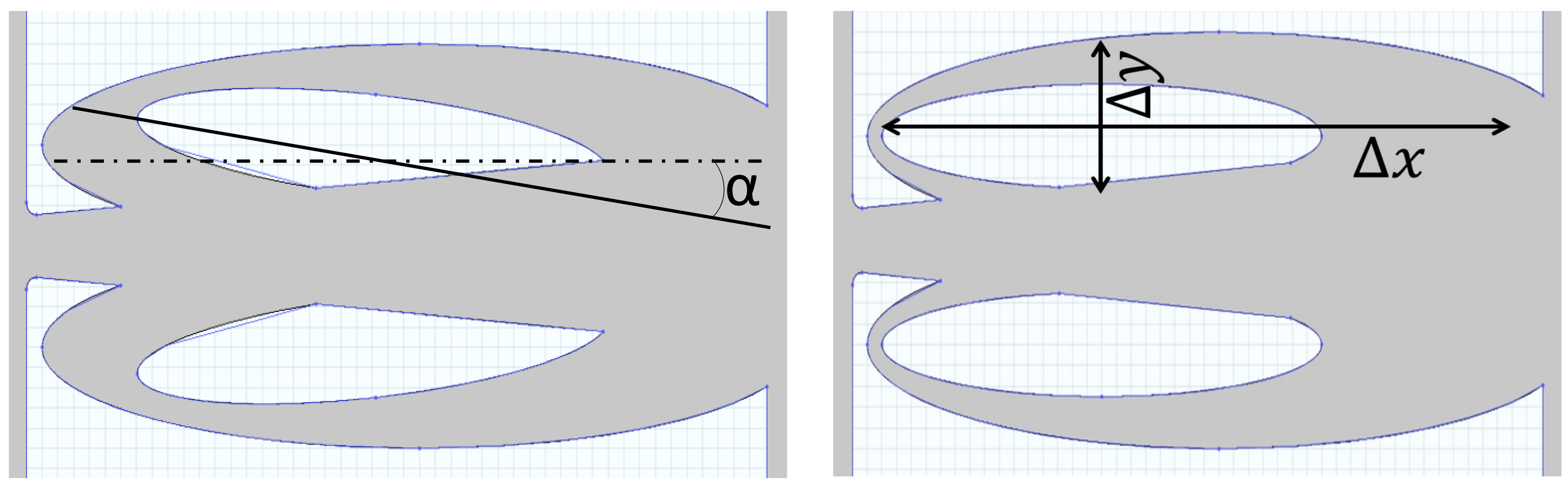

Figure 3. Geometry variation

Results: The flow rate of the optimized structures are presented in figure 4 and compared with the simple geometry flow rate (Red line). One can notice that geometry modifications lead to the improvements of the flowrate. The maximum increase observed is about 18%.

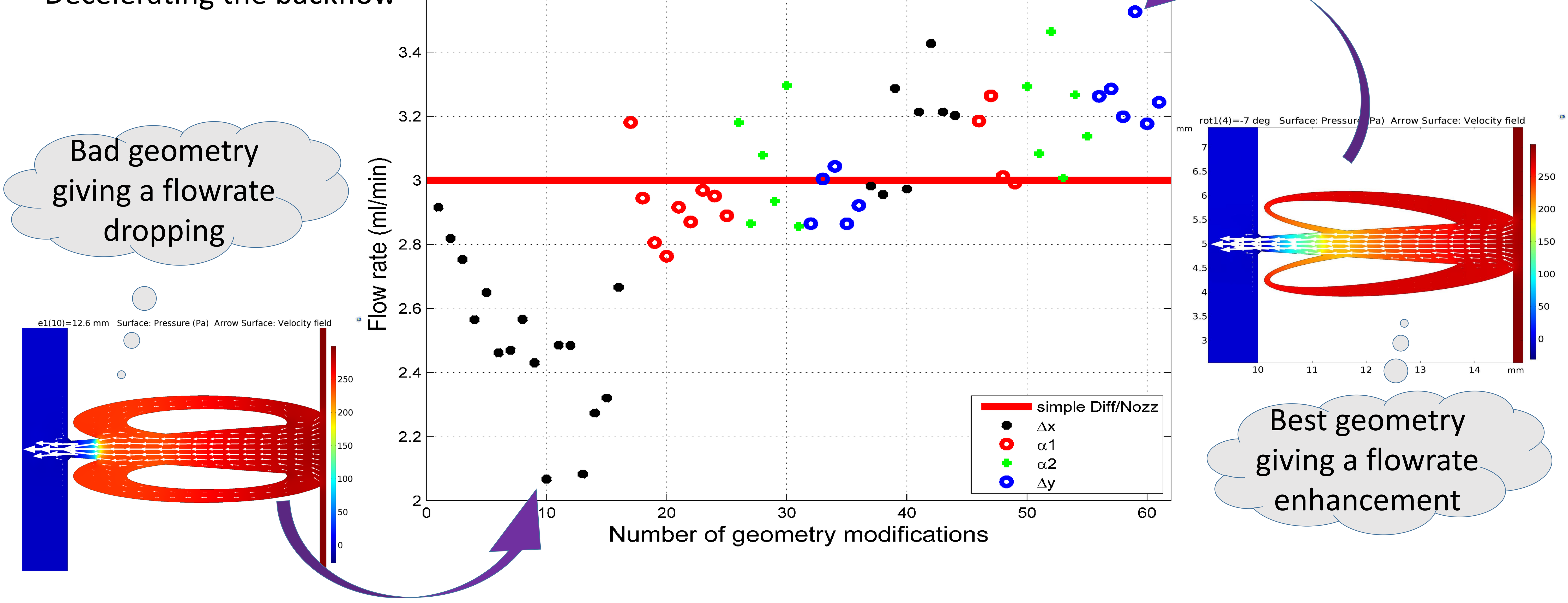

Figure 4. Flow rate variation for each geometry modification

Conclusion: These first results show about 18% of flowrate improvement and they are promising for future application of the modified geometry. This work also aims to well understand which parameters are sensitive to enhance the reliability of diffuser/nozzle geometry.