# Integrated microfluidics / lab-on-chip systems for point-of-care medical diagnostic applications


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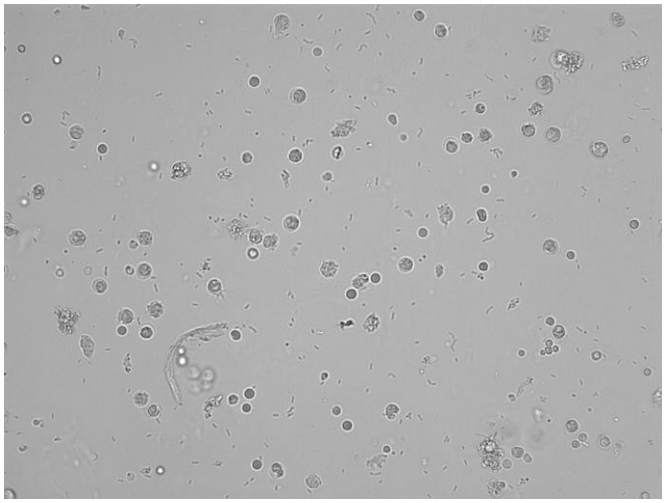
# The aim of my research

- design and development of integrated microfluidic systems for sample transporters to be used in fast and reliable diagnostic tools
- screening for urine bacteria on a targeted microfluidic platform
- study and determine the geometry and material structure of the microfluidic system;
- promoting compatibility with industrial technologies



## Main tasks of this semester

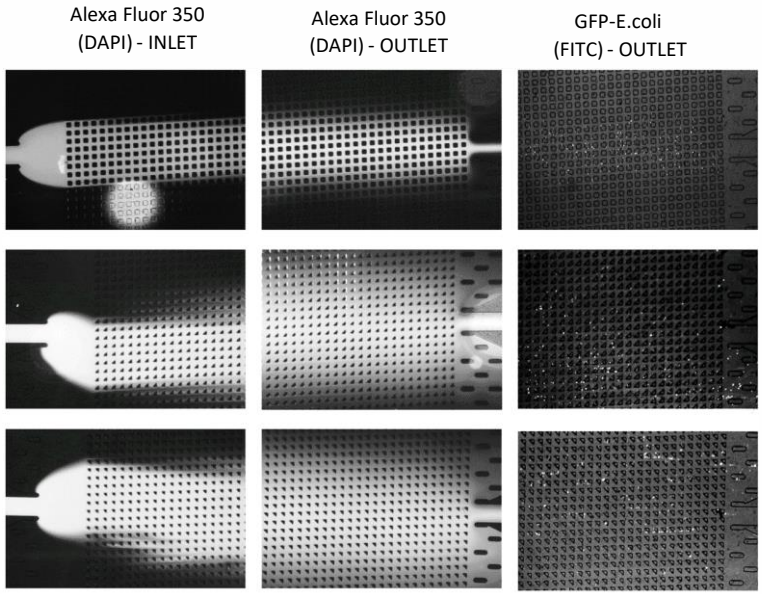
Until now passive separation methodes were tested: **Crossflow filtration (CF)** and **Lateral focusing (LF)** but in this semester investigation was made in the active separation methodes, especially in:

- **Magnetoforetic separation**

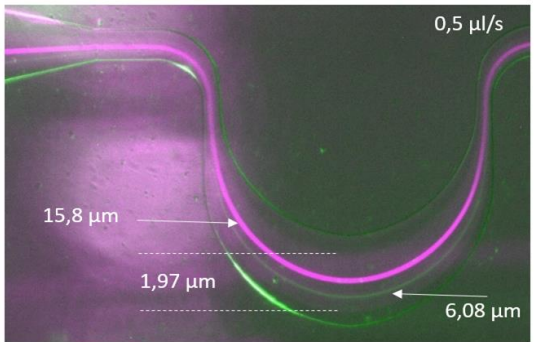
# Previous semesters – passive separation

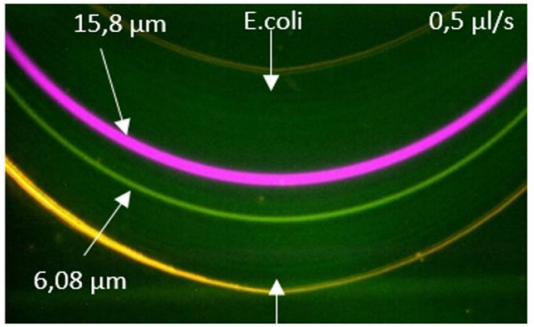


DLD



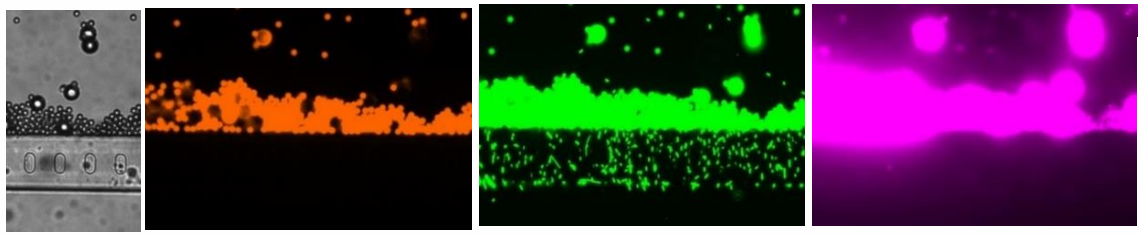

LF

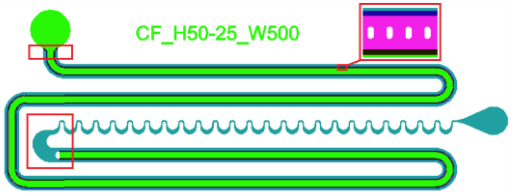


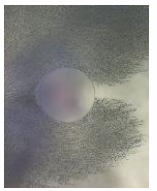

CF

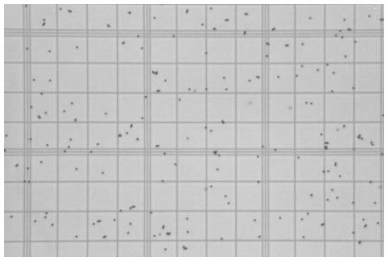
| 15,8 µm | 6,08 µm | E.Coli |
|---|---|---|
| DAPI | Cy3 | FITC |
| (purple) | (orange) | (green) |

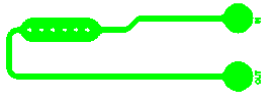


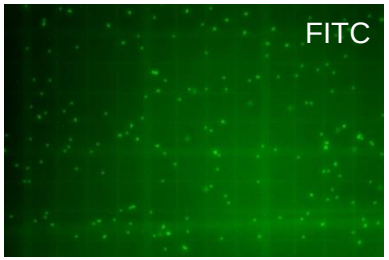


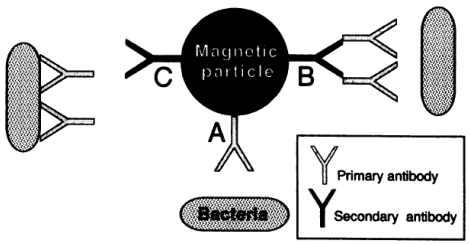
# Previous semester – active separation

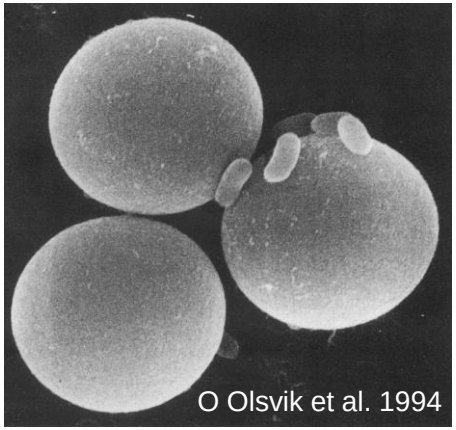


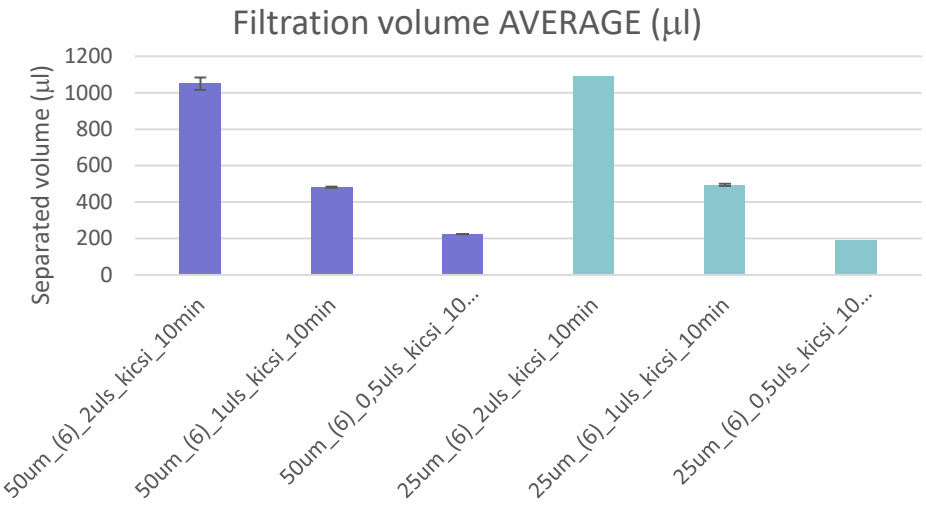


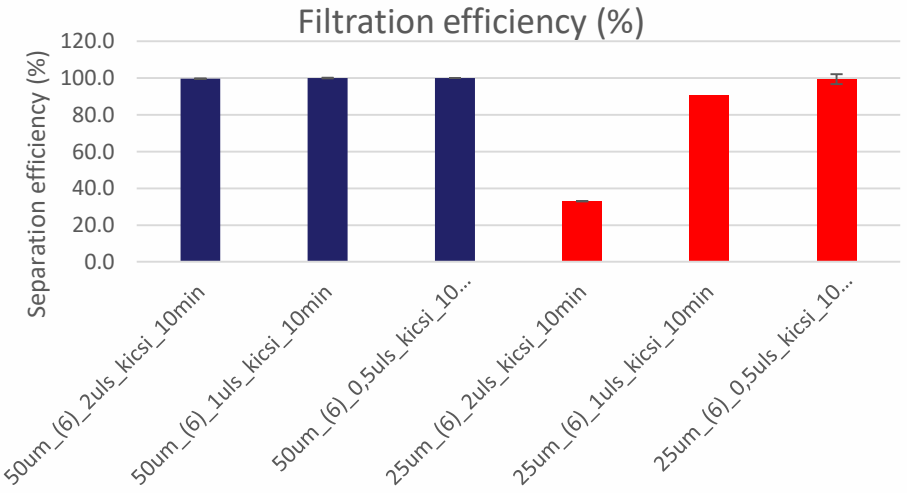




# Current semester – active separation, IVD

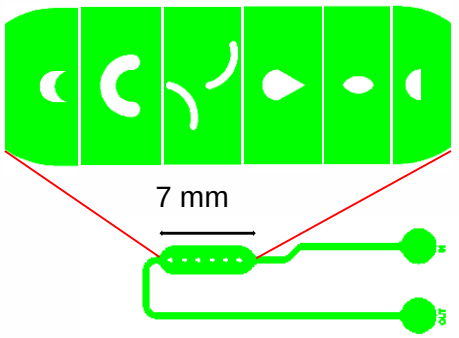
- **Manuscript writing** about Lateral focusing
  -> comparison experimental data with COMSOL simulations

- Starting the **work at 77 Elektronika Kft.** in the frame of Cooperative doctoral program: Lab-on-a Chip device development for in-vitro diagnostics (IVD) device.

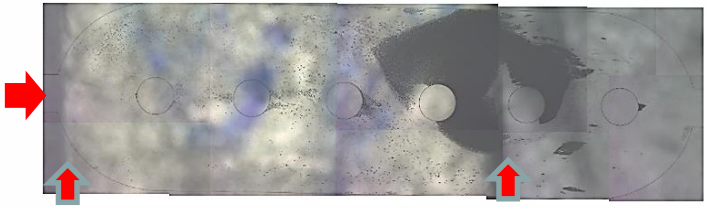
- Learning **new technological equipments**:
  - DRIE: Deep Reactive Ion Etching
  - SEM: Scanning Electron Microscope

- Studies in **Magnetoforetic separation**
  - Magnetic separation efficiency at different channel height and flow rates
  - Development of new design of microfluidic systems applicable for micromagnetic separation (MMS) with permanent neodinium magnets

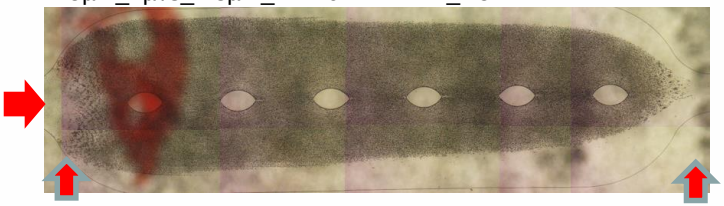
# Magnetic separation in practice



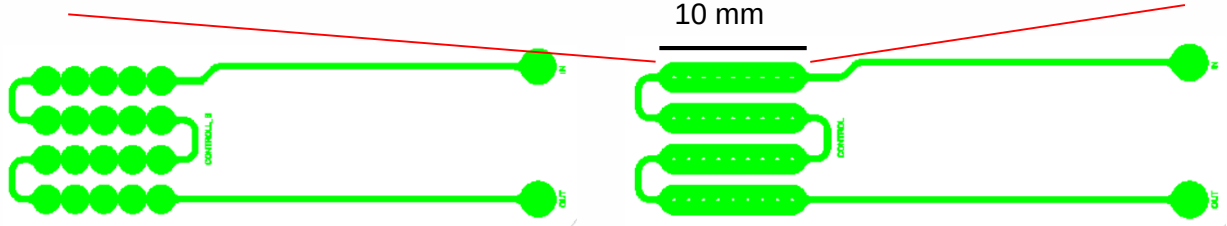

25µm_1µl/s_2.8µm_ M: 5x5x5 mm³ _N48



25µm_1µl/s_2.8µm_ M: 10x4x2 mm³_N52

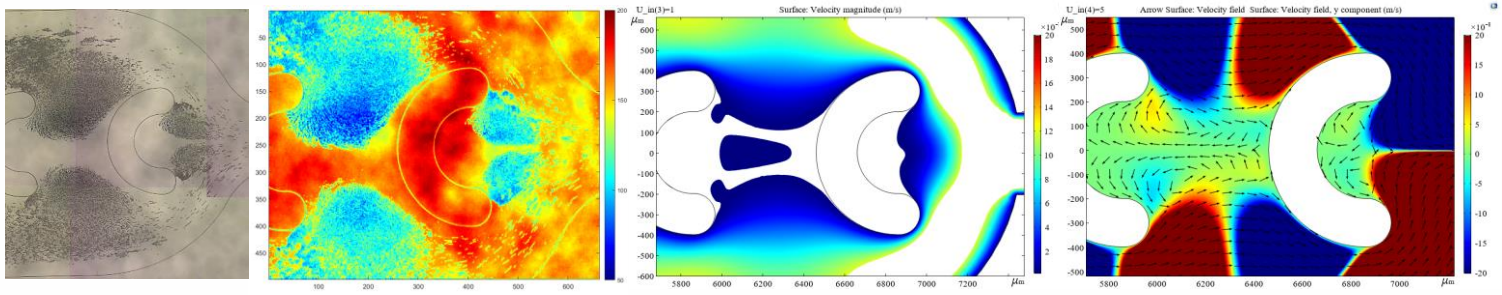


25µm_1µl/s_2.8µm_ M: 10x10x5 mm³ _N52

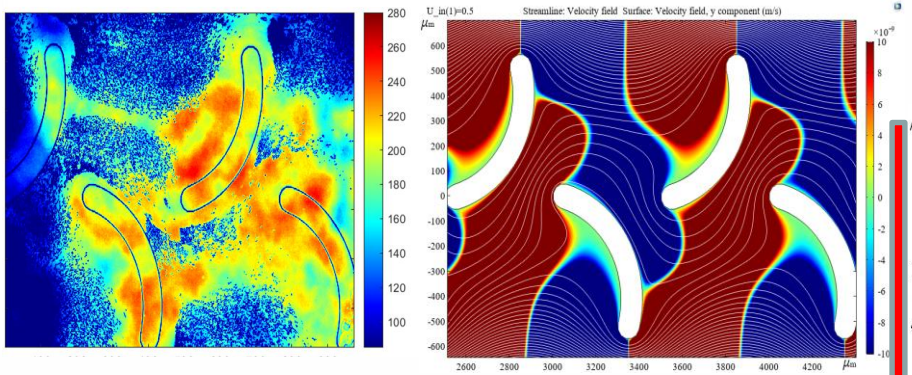


# Magnetic separation in practice

A. 1 µl/s

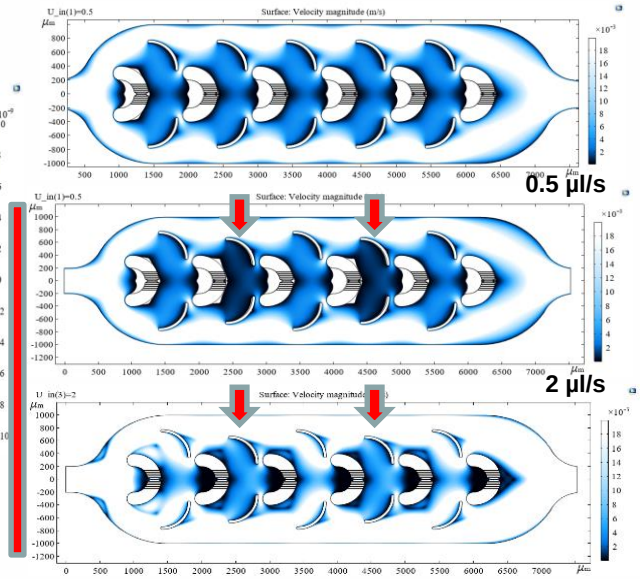



B. 1 µl/s

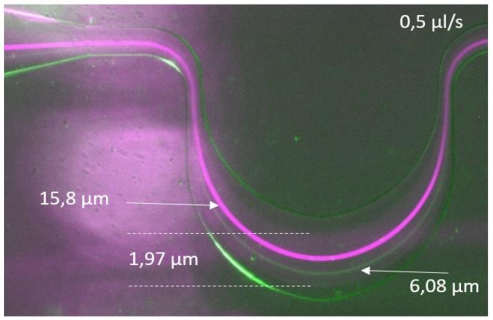



C.

0.5 µl/s



# Magnetic separation in practice



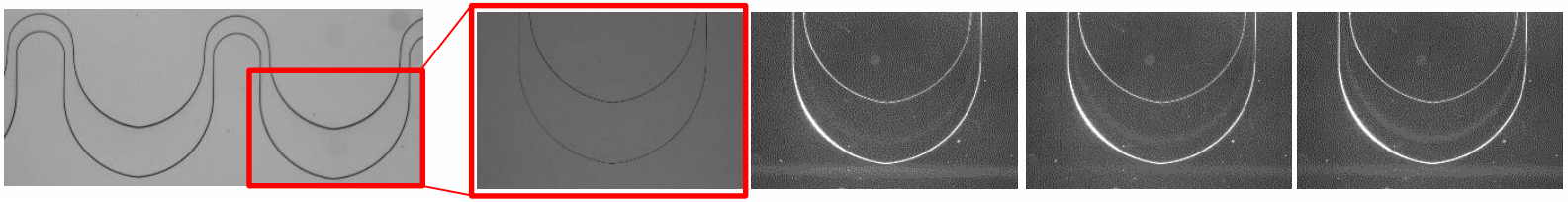

M25K50

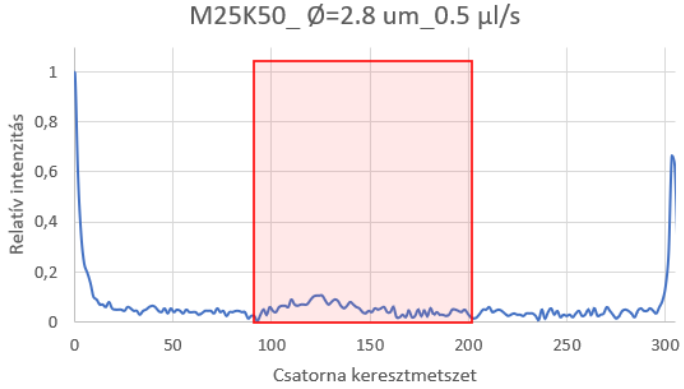
**M25K50 – 2.8 µm**
**Mágneses gyöngy**
**Cy3 – 1400 ms**

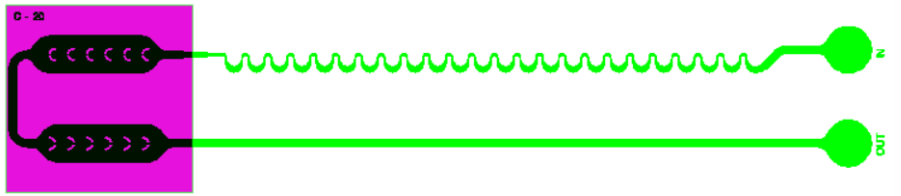
0.5 µl/s

1 µl/s

2 µl/s





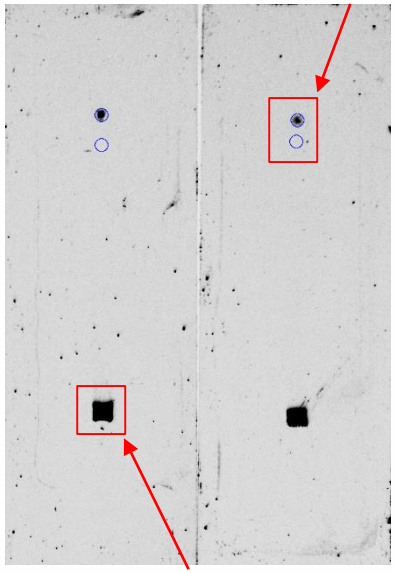
# Work at 77 Elektronika Ltd.

## IVD in combination with LOC

- Immunoassay preparation on COP
- Special microfluidic structure for sample preparation
- Aim: to detect the exact concentration of biomarkers (NT-proBNP, CRP) from blood
- Conclude the presence of cardiac disease or inflamation in patient

Rapid test evaluation

Signal to noise ratio



Antigen spike in blood sample

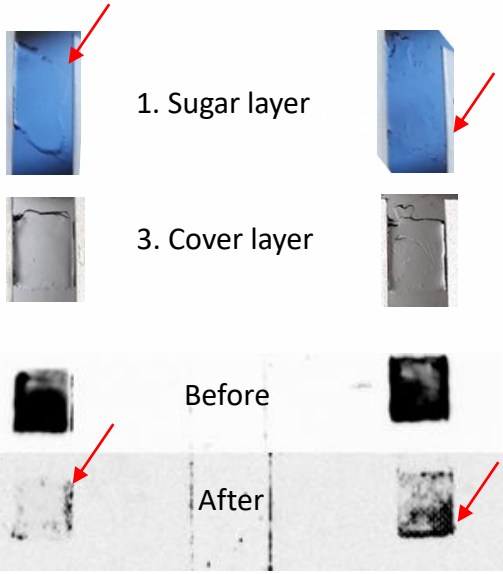
Antibody coated microbeads

Before sample handling

After sample handling

I.

II.



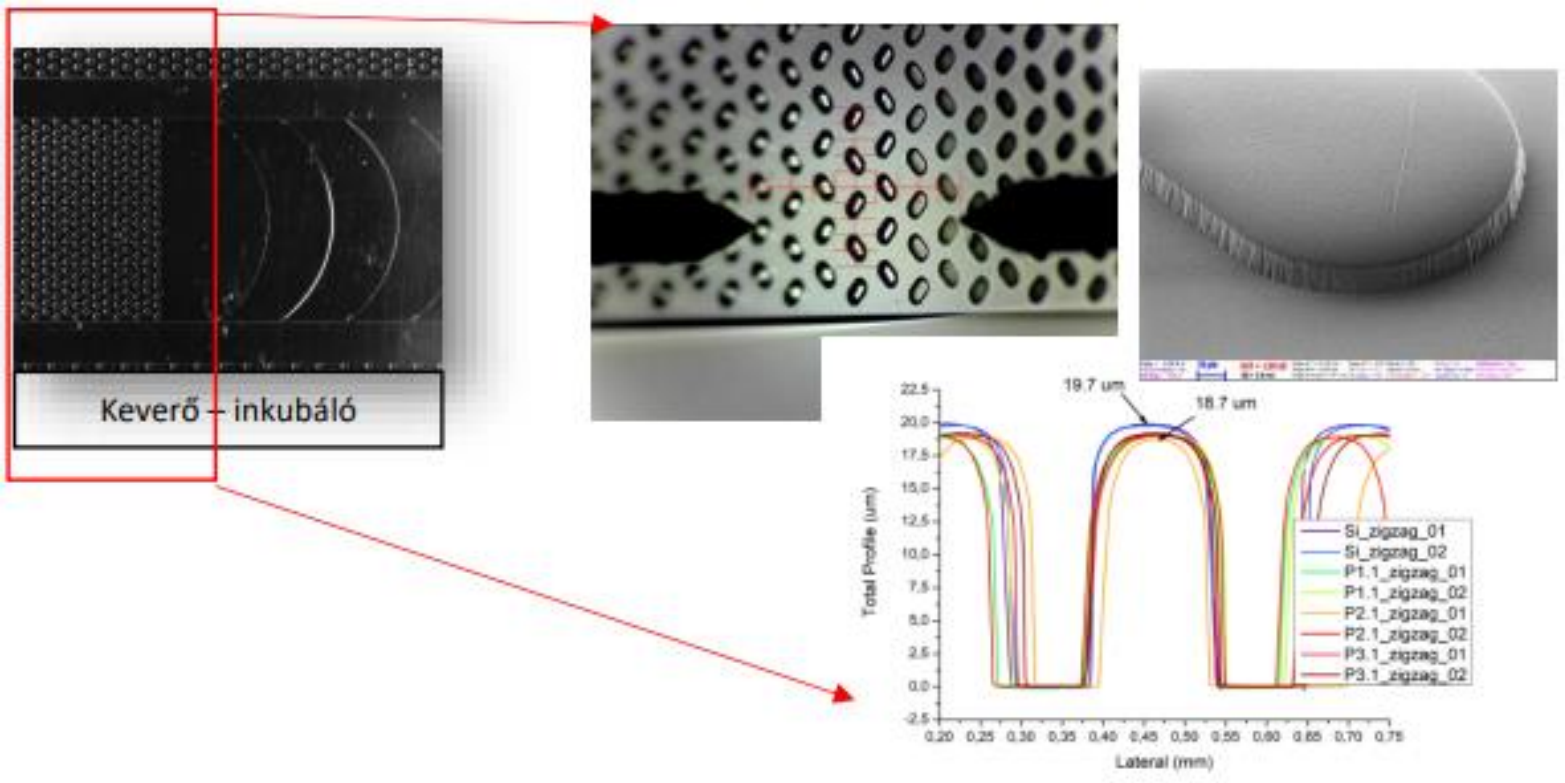
1. Sugar layer

3. Cover layer

Before

After

# KDP - Hot embossing



# Summary

- Magnetic separation was investigated by using magnetic beads (2.8 μm diameter) in 25 μm height chambers at 1 μl/s flow rate
- Experimental results were compared to numerically calculated data, and optimised design was developed for bettel lateral concetration.
- Lateral concetration of 2,8 μm beads were also tested in M25K50 curved channels at 0,5 μl/s flow rate.
- Work started to meet the chellenge of mass production: Si master / hot embossing / injection moulding.

# Plan

- Futher biological measurements in the Lateral focusing structure with real biological samples (RBC, E.Coli, yeast cells) – finishing next manuscript.
- To continue magnetic separation with the new design (smaller beads, E.coli or extracellular vesiculas)
- Futher investigation in DRIE methods

# Subjects

- György Kaptay: Art of doing Science

# Presentetions

- In the frame**work** of the Doctoral Initiation Program of the University of Óbuda on September 1, 2021, in the research topic of the Cooperative Doctoral Program: 'Integrated microfluidic / Lab-on-a-chip systems for point-of-care medical diagnostic applications' I presented my research project
- Energy, Modern Materials, Medical Diagnostics, Research and Development and Education Cooperation between the Energy Science Research Center and the University of Óbuda: I was able to give a lecture at a professional conference on the applicability of microfluidic devices on 08.11.2021.

# Publications

- **Development and in-depth characterization of bacteria repellent and bacteria adhesive antibody coated surfaces using optical waveguide biosensing (accepted)**
  Eniko Farkas[a], Robert Tarr [a,b], Tamás Gerecsei [a,c], Andras Saftics [a], Kinga Dóra Kovács [a,c], Balazs Sterczd[d], Judit Domokos[d], Beatrix Peter[a], Sandor Kurunczi[a], Inna Szekacs[a], Attila Bonyár[c], **Anita Bányai**[e], Péter Fürjes[e], Szilvia Ruszkai-Szaniszlóf, Máté Varga[f], Barnabás Szabó[f], Eszter Ostorházi[d], Dóra Szabó[d], Robert Horvath[a]

*__Biosensors__ (JCR - Q1 (*Chemistry, Analytical*) / CiteScore - Q2 (*Clinical Biochemistry*),
Impact Factor: 5.519 (2020) ; 5-Year Impact Factor: 5.313 (2020)