Organ-on-chip devices

PhD Report – 5th semester

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25.01.2024

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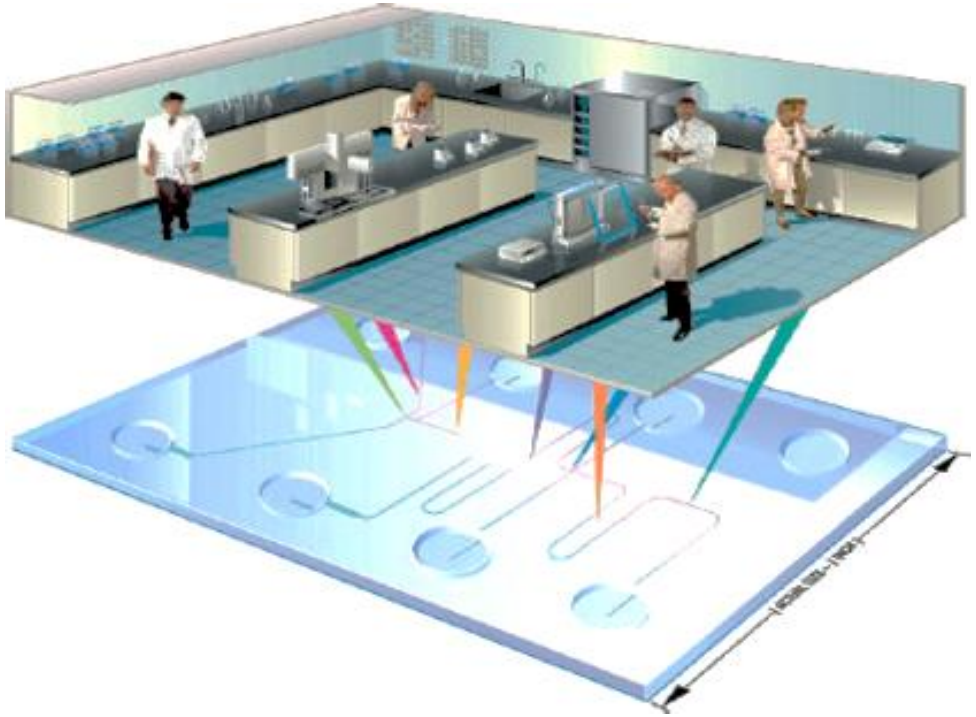
Introduction

- Microfluidics: precise control and manipulation of fluids on a micrometer scale
- Small Reynolds number: viscous forces, laminar flow
- Capillary flow, autonomous flow
- Advantages of size: portability, low consumption (sample, reagents)
- Lab-on-a-chip: miniature version of a complete laboratory
- Organ-on-a-chip: cell cultures, tissues on a microchip
- Generating chemical gradients
- Cell-trapping and behaviour monitoring
- Measurements with bacteria and antibiotics

Goal: chemical gradient generation, cell-trapping, electrode integration, impedance spectroscopy based measurements, rapid antibiotic resistance measurements

Lab-on-a-chip

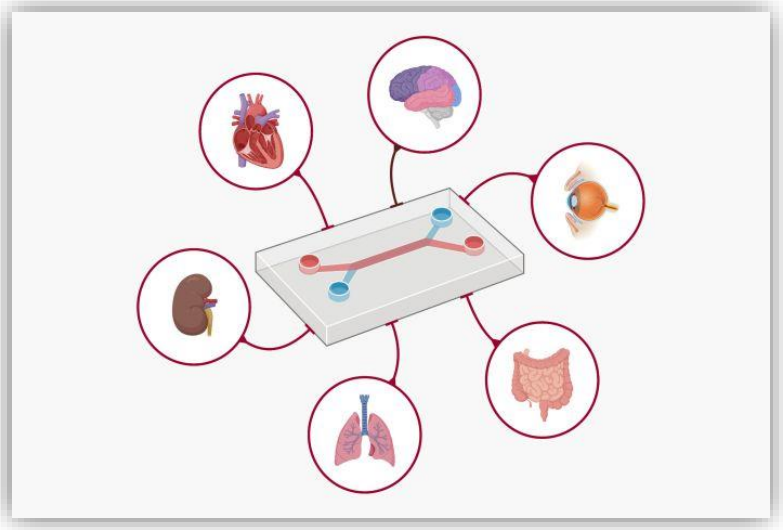


Polimer alapú mikrofluidikai eszközök technológiája, Holczer Eszter

Advantages:

- Low consumption, reduced waste
- Point-of-care
- Fast, precise, controllable
- Low cost, disposable

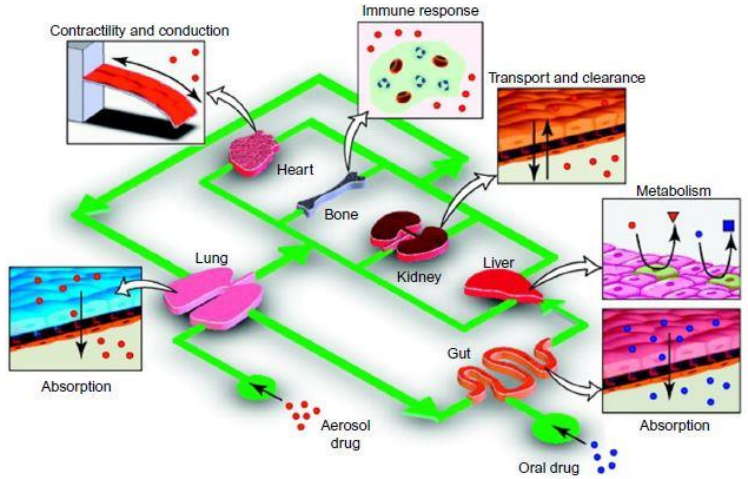
Organ-on-a-chip



https://www.ufluidix.com/microfluidics-applications/organ-on-a-chip/

Advantages:

- Reduce or replace animal testing
- Drug development and tests
- Cancer research

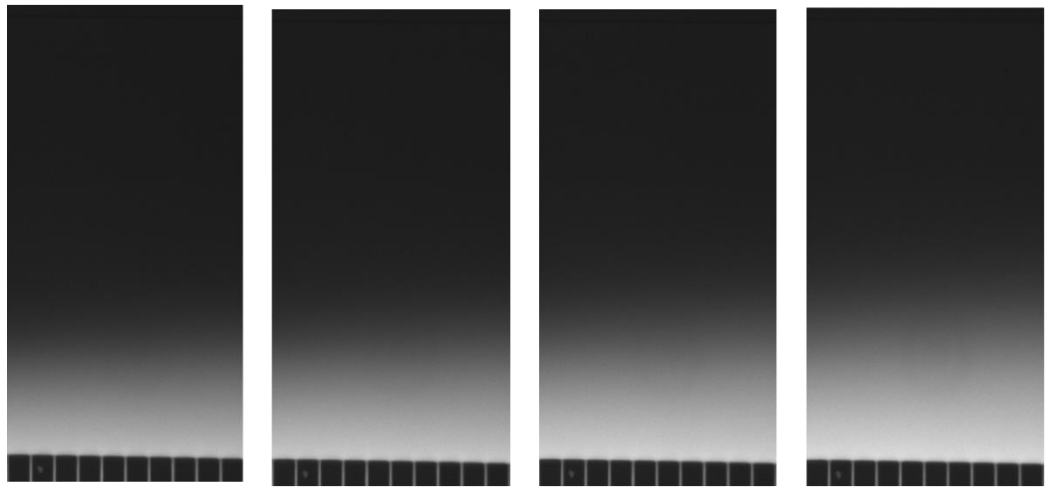


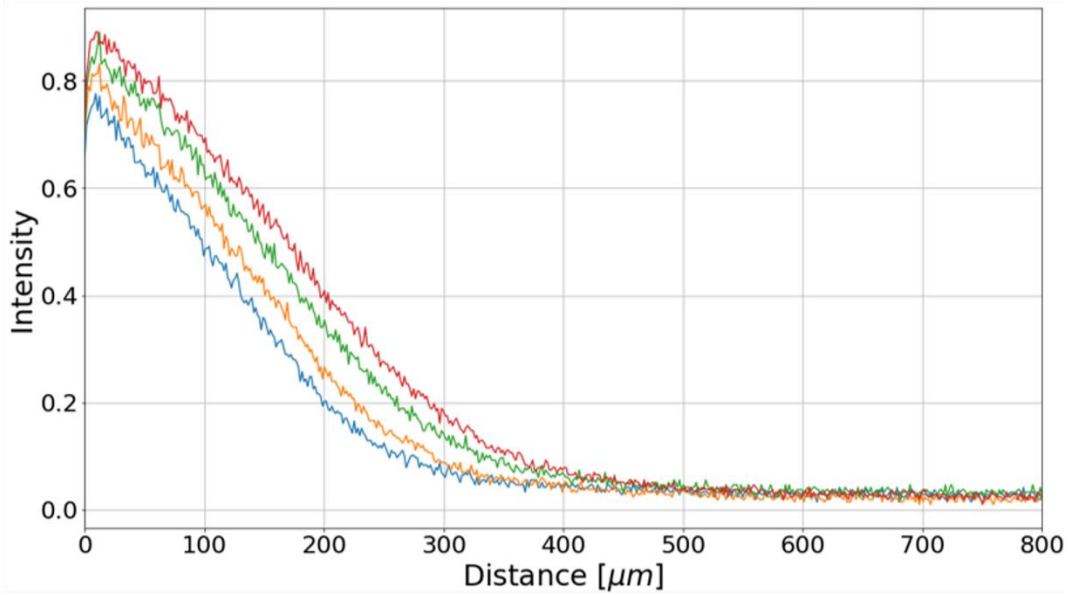
Lab-on-a-chip technology and microfluidics: Antonio Francesko, Vanessa F. Cardoso, Senentxu Lanceros Mendez, 2019

Results in previous semesters

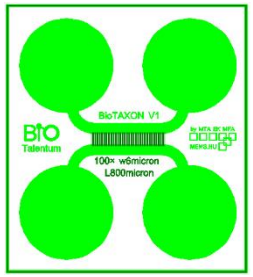
Protein Diffusion: BSA, IgG, Rh B

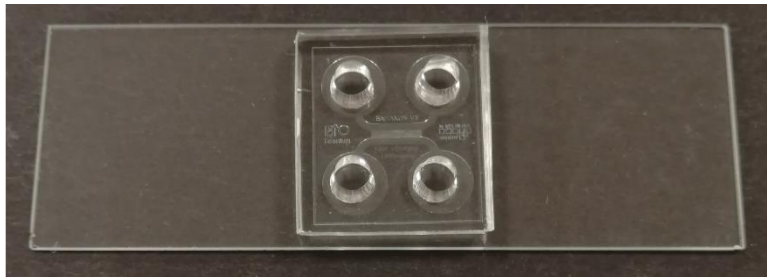
- Publication: Manuscript under submission
- Python evaluation program, error function fitting





Material	D of measurement [$\mu m^2/s$]	D in literature [$\mu m^2/s$]
BSA	64.24 ± 0.63	60.7, 63.8, 72
IgG	38.95 ± 0.29	38, 40
Rh B	372.74 ± 3.32	360, 420 ,427

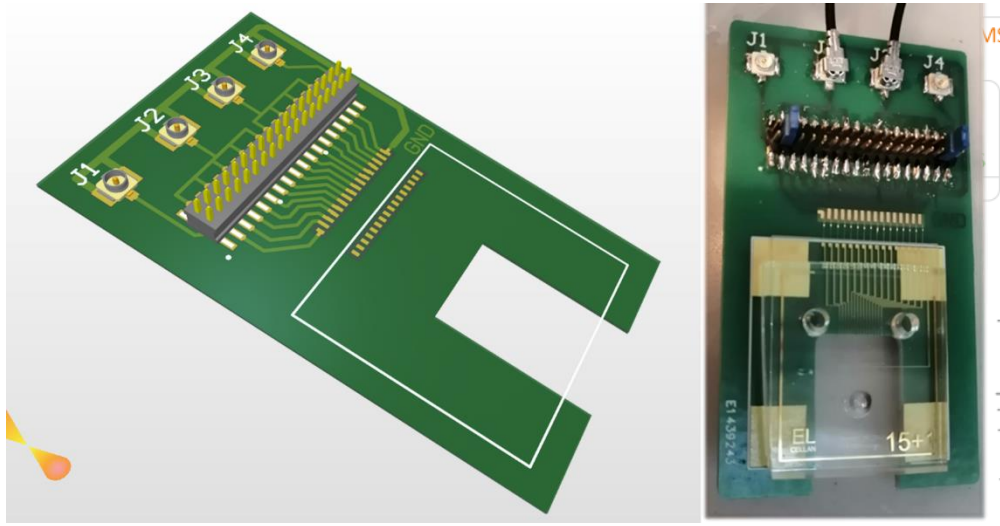


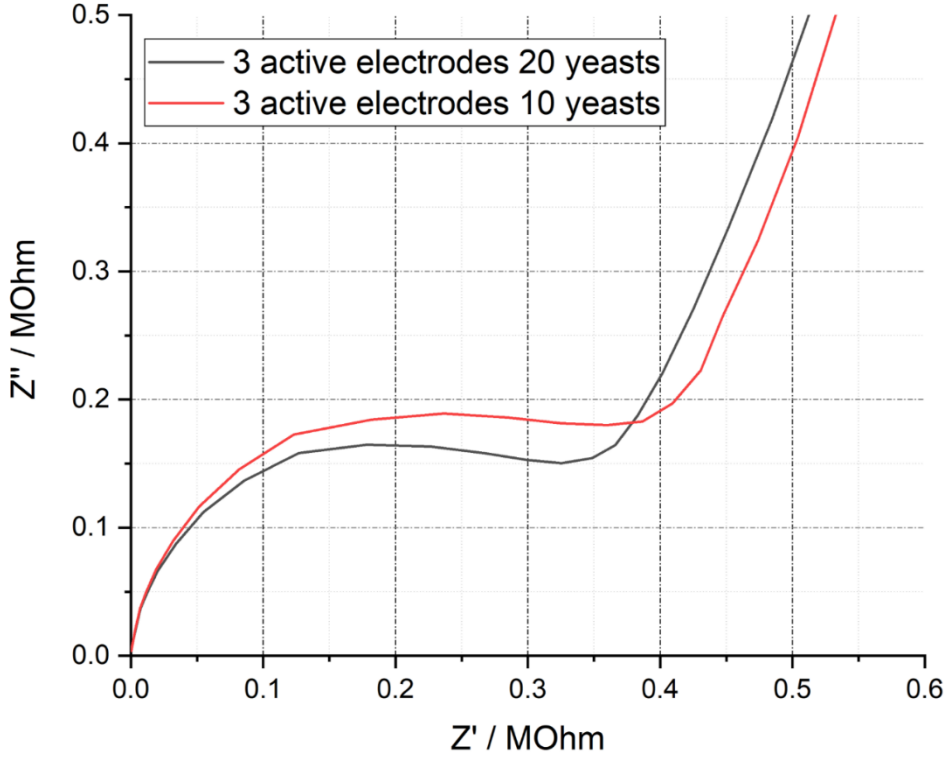


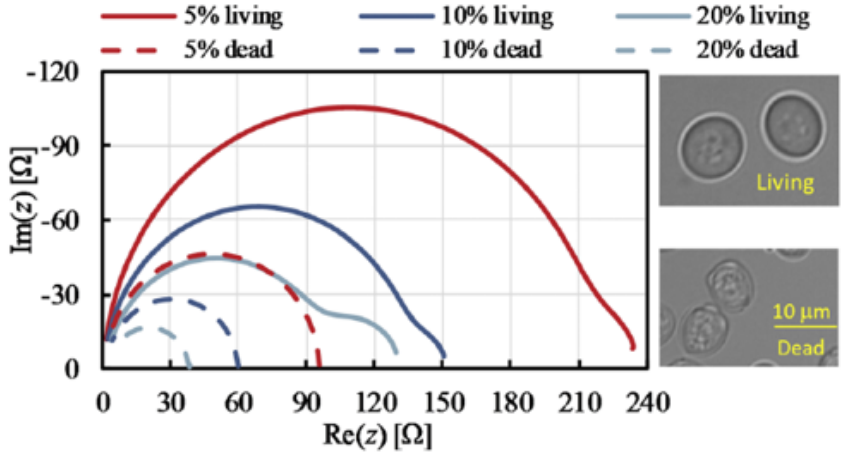
Results in previous semesters

Device assembly

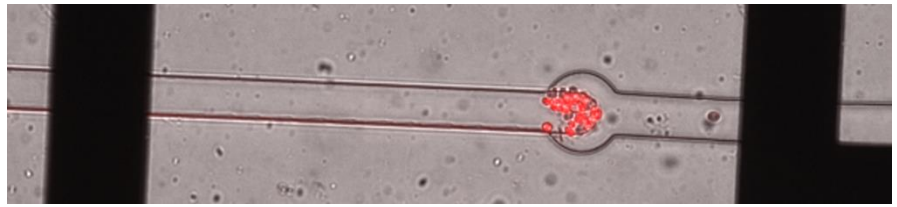
- PCB fabrication
- Au and Pt electrodes
- 4 channels measurement
- Connection with PalmSense4
- 0.05 mg/ml yeast solution in PBS with 10 mg/ml Glucose and PI staining







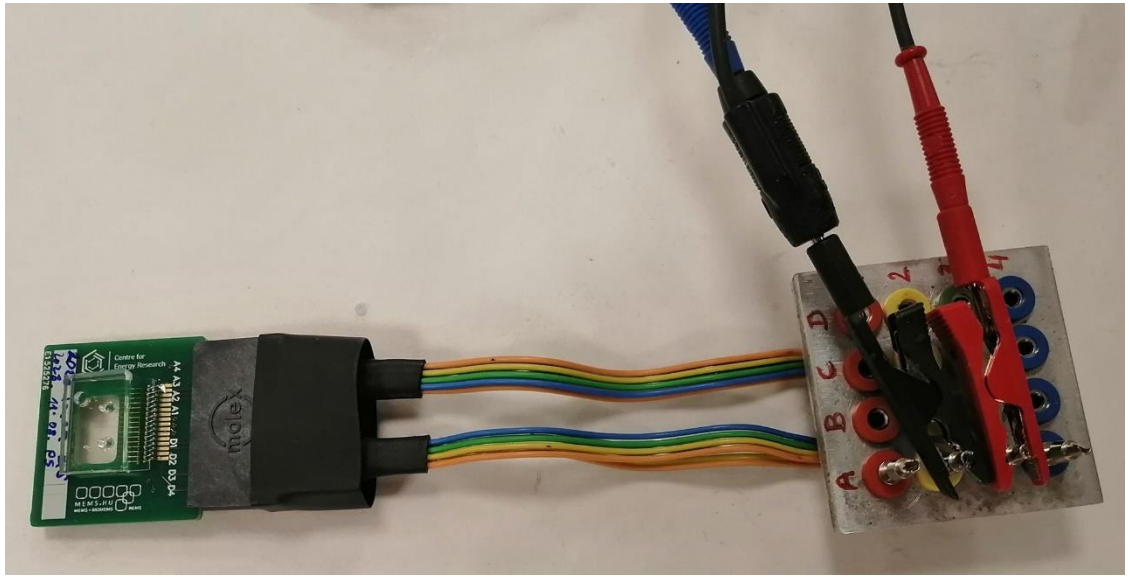
Li Wang et al. A hybrid Genetic Algorithm and Levenberg–Marquardt (GA–LM) method for cell suspension measurement with electrical impedance spectroscopy



Results in current semesters

Measurements

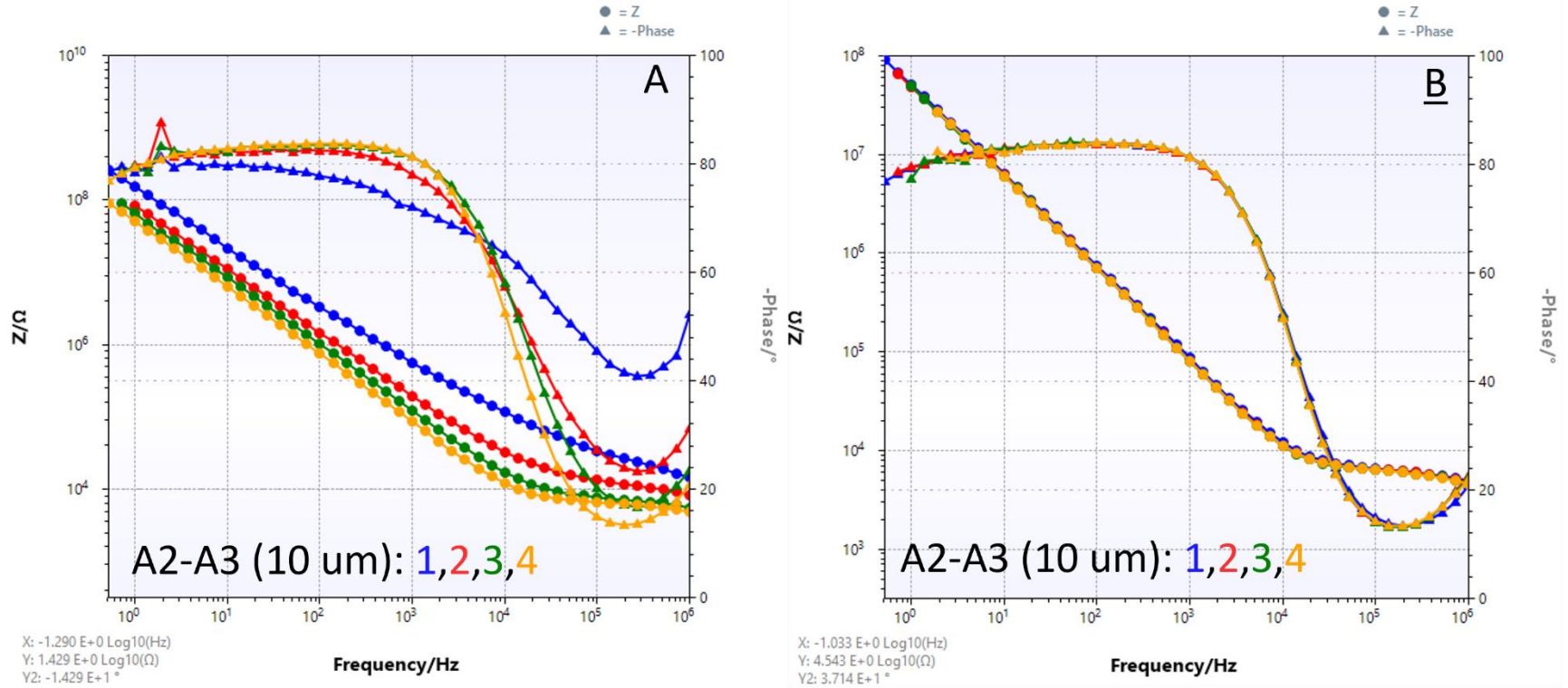
- New device
- Electrodes closer for enhanced sensitivity, d=10-20 µm
- Au, Pt electrodes on glass, SU-8 walls, PDMS top
- Central barrier for cell trapping
- Possibility for 4-electrode measurements
- ÚNKP: Impedance tomography in microfluidics



Results in current semesters

Measurements

- PalmSense4 for 2-electrode, bioEIS for 4-electrode measurements
- 100% biological saline solution
- Testing doublelayer formation and reproducibility
- 2-electrode (200 mV) or 4-electrode (1V, 100 mV) measurements
- Electrodes degrade over time, high voltage does damage



Publications

- Under submissin: Manuscript of protein diffusion coefficient measurements
- Published– Hungarian Article:
  - *Bányai Anita; Bató Lilia; Leelőssyné Tóth Eszter; Varga Máté, Fürjes Péter,* ***Áramlástani jelenségek mikroszkopikus mérettartományban – mikrofluidikai rendszerek és alkalmazásaik,*** *Fizikai Szemle – Magyar Fizikai Folyóirat*

Previous conferences

- Mátrafüred 2022 – International Meeting on Chemical Sensors – Poster (June 12-17)
  - *Lilia Bató , Péter Fürjes,* ***Individual cell trapping and viability testing in microfluidic device****, Mátrafüred 2022 – International Meeting on Chemical Sensors, Visegrád, Hungary, 2022*

- Rotterdam 2022 – Lab-on-a-Chip Microfluidics Europe – Poster (June 21-22)
  - *Lilia Bató, Péter Fürjes,* ***A fluorescent detection method to measure the diffusion coefficients of proteins in a free-diffusion based microfluidic system****, Lab-on-a-Chip Microfluidics Europe 2022 Conference, Rotterdam, The Netherlands, 2022*

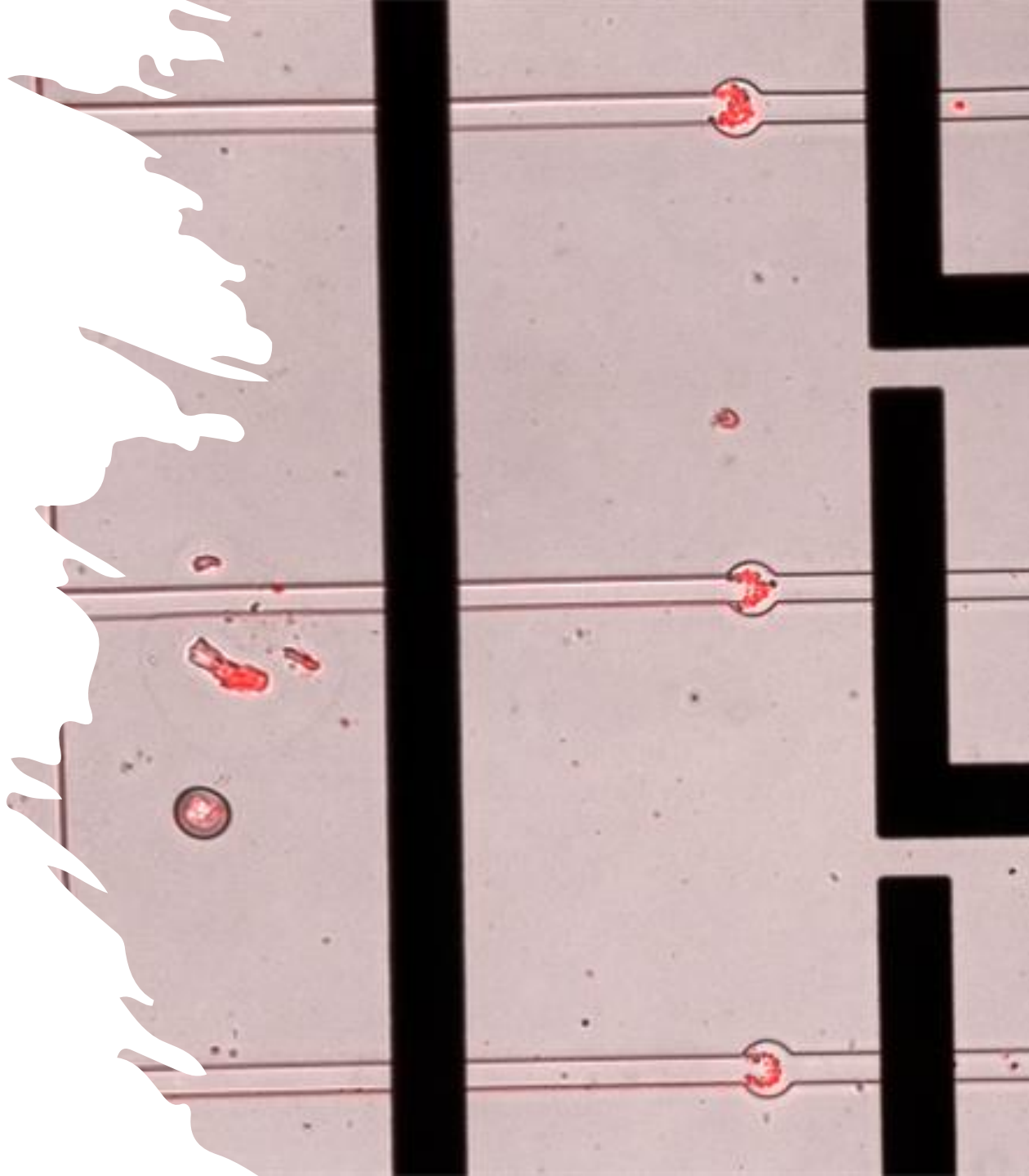
- Budapest 2023 – Oral presentation (August 28-31)
  - *Lilia Bató and Péter Fürjes,* ***An obstacle-free microfluidic system for monitoring protein diffusion,*** *MBFT XXIX Congress, Budapest, Hungary, 2023*

- Lecce 2023 – Poster (September 10-13)
  - *Lilia Bató and Péter Fürjes,* ***Microfluidic system with integrated electrode array for EIS analysis of localised cells,*** *" Eurosensors 2023 Conference, Lecce, Italy, 2023*

Future plans

Research

- Impedance spectroscopy measurements on trapped yeast cells
- Electrode design for better signal, higher surface area
- Rapid antibiotic resistance measurements (E. Coli)



Thank you for your attention!