Towards electronic microplates with multimodal sensing for bioassays

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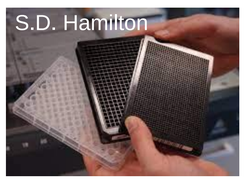
Introduction

Bioassays are versatile bioanalytical methods, based on the use of microplates for **analytical research** and **clinical diagnostic testing**.



Bioassays

ELISA
Cell Viability Assays
Enzyme Activity Assays
Fl. Based Assays
TEER
Cytotoxicity Assays
Cell Adhesion Assay
Migration/Invasion Assay
Microbial assays
...

State-of-the-Art readout

Optical techniques
Absorbance
Fluorescence
Luminescence
Light scattering
...

Microplate reader

Microscope

biorender.com

Pros
High sensitivity
Versatility

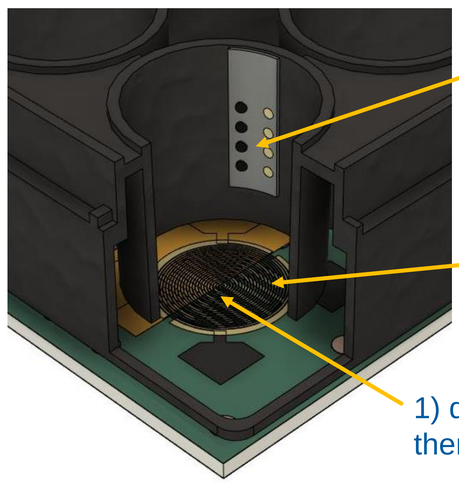
Cons
Labeling/staining
Time consuming
No real-time data
Lack of automation
High costs
Trained personnel

Our solution

Electronic microplates

Seamless integration of flexible, multimodal actuator/ sensors into microplates:

1) Thermal interface
2) Electrochemical impedance spectroscopy (EIS)
3) Extended Gate Field Effect Transistor (EGFET)-based biosensing



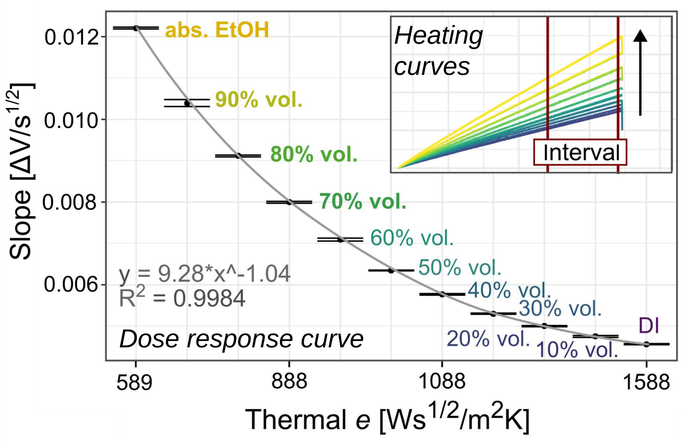
Modality 1 - Results

Thermal interface

Non-contact element with the dual function of **temperature control** and **thermal sensing**.

PID-temperature controller

SP = Setpoint



Thermal effusivity sensor

Model system
DI water – EtOH mixtures for measuring thermal effusivities in relevant range

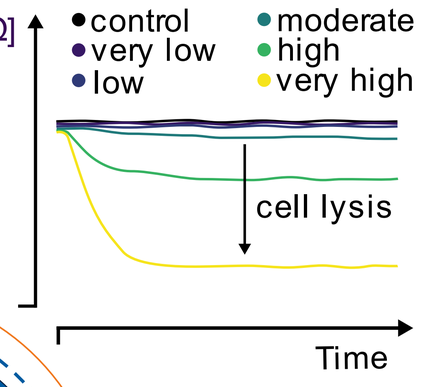
Interdigitated electrodes for the electrical **characterization** or **stimulation** of biological sample.

Modality 2 - Conceptualization

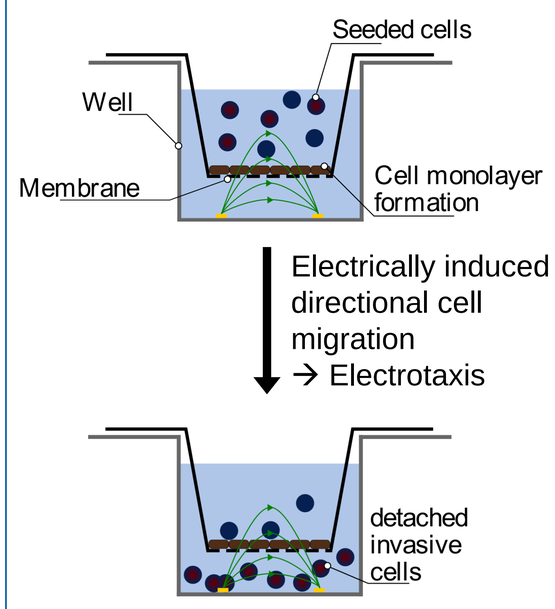
Impedance interface

Example: **Cytotoxicity assay**

Increasing concentration of cytotoxic drug will lead to disruptions of the cell monolayer and lysis of the cells.



Example: **Electrical stimulation**

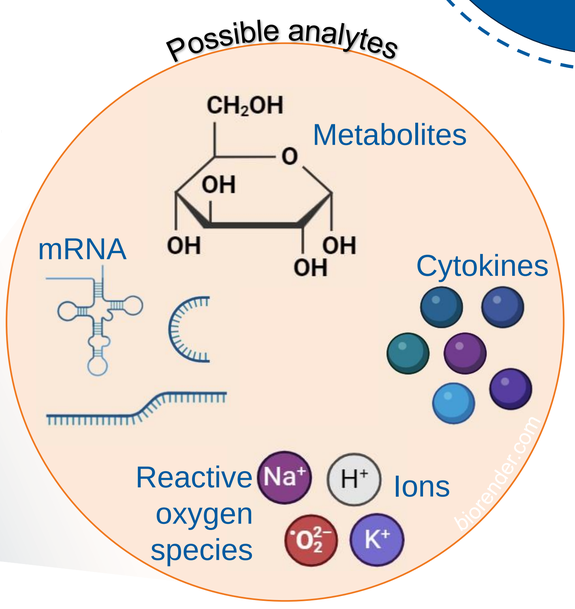


Electronic microplate

Modality 3 - Conceptualization

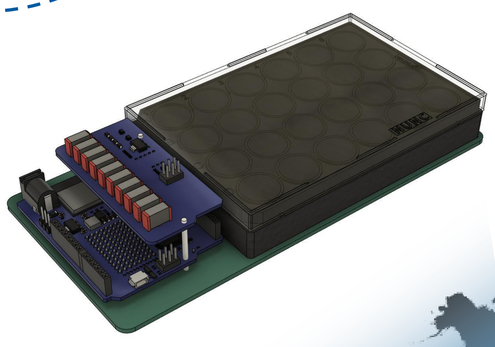
Specific biomarker sensing

Continuous monitoring of ***various biomarkers*** using a multiplexed extended gate field effect transistor-based readout with surface functionalized working electrodes.

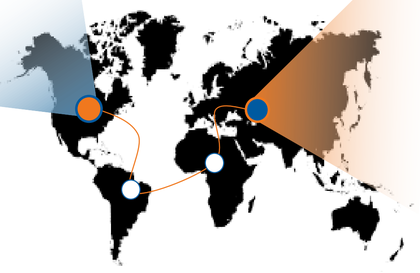


Perspective

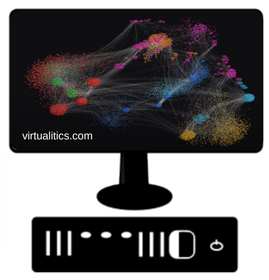
Low-cost wireless readout device and cloud-based analysis



Arduino Uno R4 Wifi based control with low-cost electronic ***multiplexing module*** and ***readout module***



Arduino IoT cloud for remote monitoring and controlling of the assay



Global collaboration in research and clinical settings

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EKFZ Digital Health

Project *ImmunoChip*
HORIZON EUROPE

Funded by the European Union
erc European Research Council
Established by the European Commission

DRESDEN concept