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Abstract #229

A bio-impedance measuring platform with a full-spectrum measurement head and an adaptable lid for well plate format to monitor barrier-on-chip

Shaginth SIVAKUMAR[*1], Harley Stoeckli [2], Nicola Giandomenico [2], Marc O. Heuschkel[1], and Adrien ROUX[1†]

[1] Bioengineering Group, [2] Electronic Group, HEPIA HES-SO University of Applied Sciences and Arts Western Switzerland, Geneva, Switzerland.

*Presenting author: shaginth.sivakumar@hesge.ch ;†Corresponding author: adrien.roux@hesge.ch

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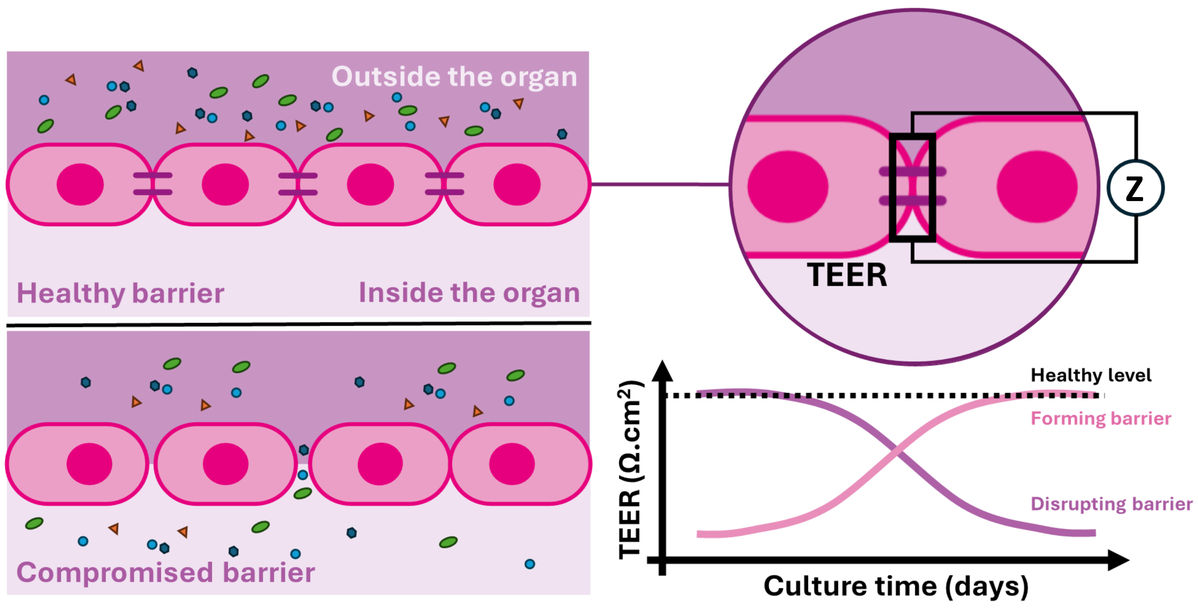
INTRODUCTION

The UNLOOC project addresses the challenges of animal testing in drug development by advancing *in vitro* Organ-on-Chip (OOC) technology. Within HES-SO, HEPIA is developing a complete system to monitor cell barrier integrity using bio-impedance in a novel lung-on-chip platform by developing acquisition electrodes, a measurement head and a software.

Lung epithelial cells are cultured in dynamic conditions at the air-liquid interface (ALI). The bio-impedance system scans a wide frequency range from 1 Hz to 100 kHz and extracts trans-epithelial electrical resistance (TEER) at ALI. Currently, TEER is only measured In-liquid Interface (ILI), which is less physiological for the cells. This new approach will use the TEER to enable quantification of cell barrier formation, disruption, and maintenance during drug testing in more physiological context.

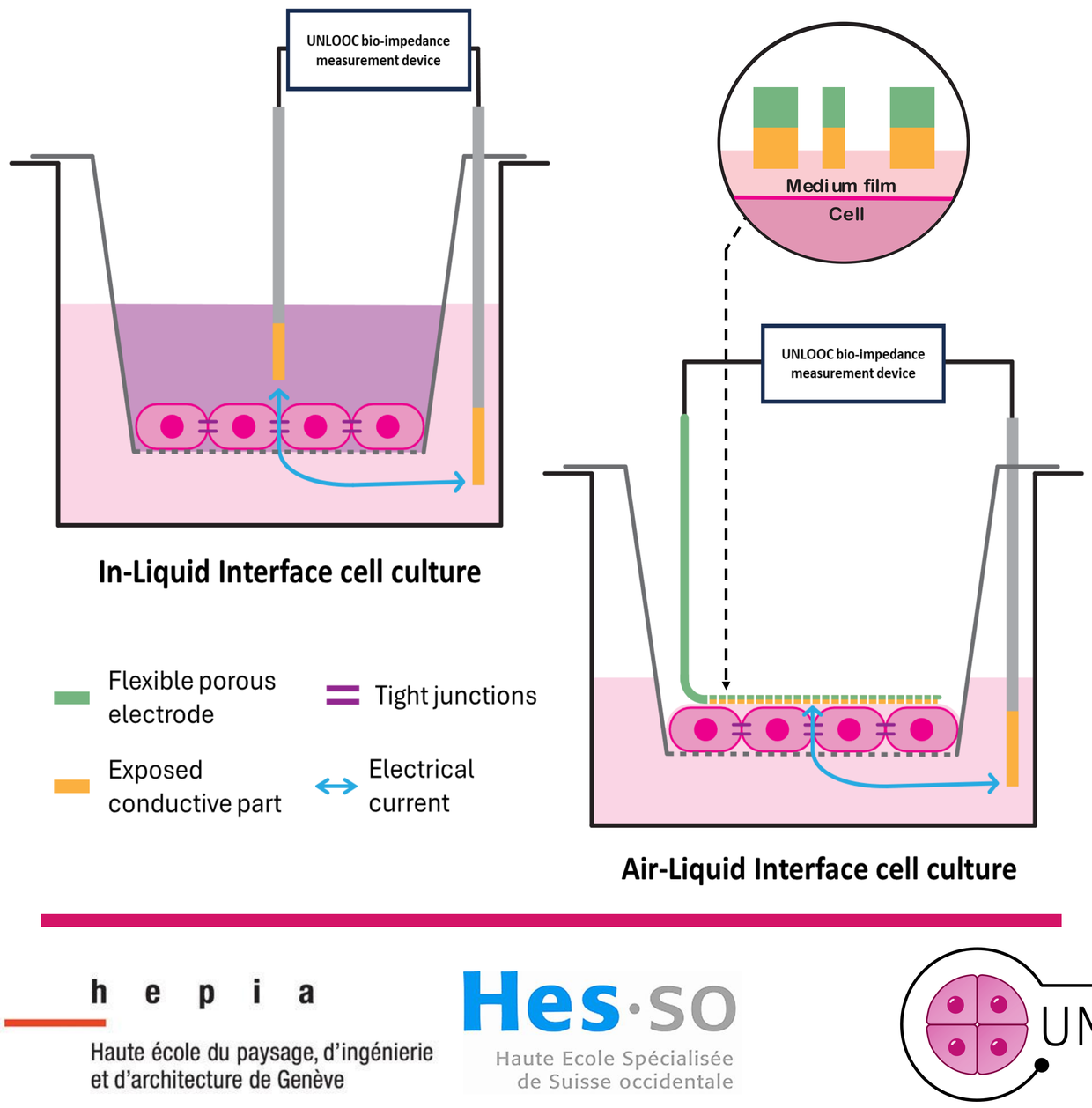
METHODOLOGY

Schematic overview of Trans-Epithelial/Endothelial Electrical Resistance



Airway epithelial cell barriers are composed of airway epithelial lung cells, tight junctions, and a mucus layer, which separate and protect the organ from the inhaled air. Once the epithelial cells become confluent, they form tight junctions that regulate the passage of molecules across the barrier. Ions are also regulated by the tight junctions, resulting in a trans-epithelial electrical resistance (TEER) at the formed barrier. Thus, the TEER directly reflects the integrity of the cell barrier.

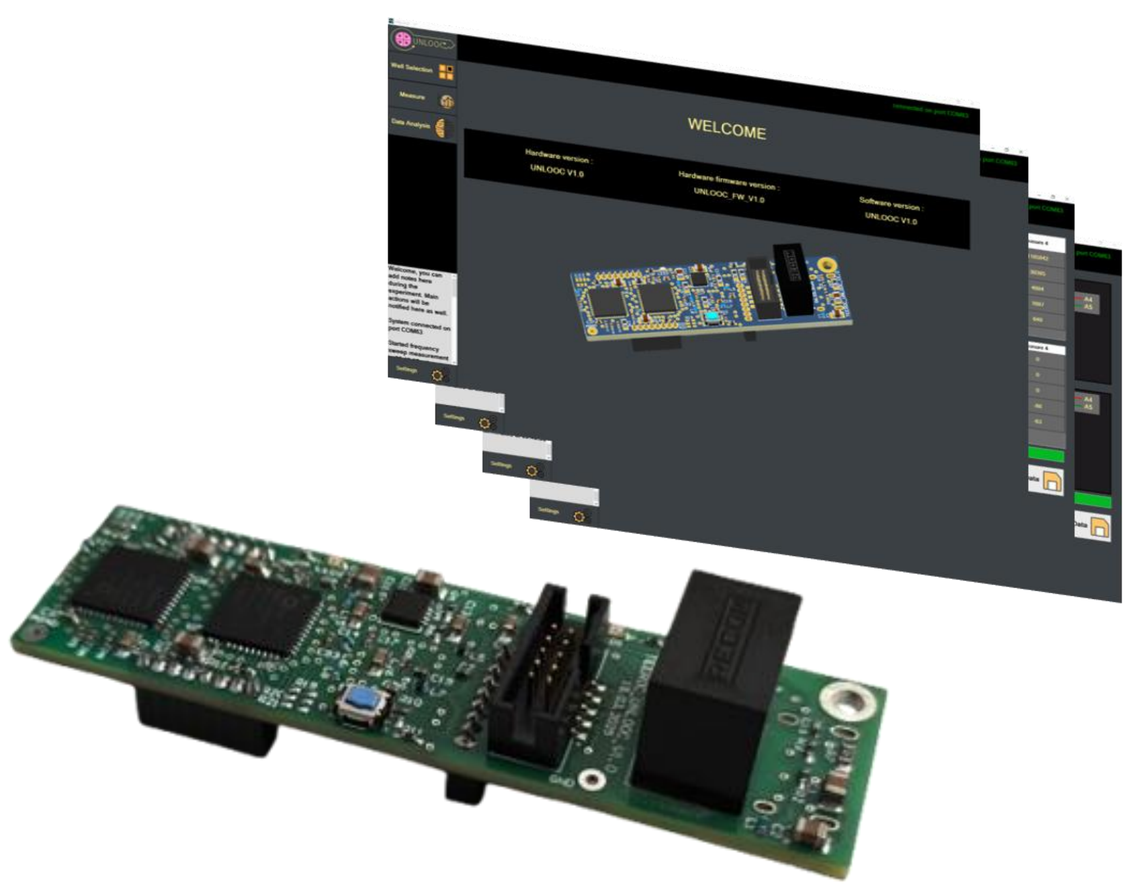
Schematic representation of TEER monitoring on epithelial cells cultured on inserts in-liquid interface vs air-liquid interface conditions



RESULTS

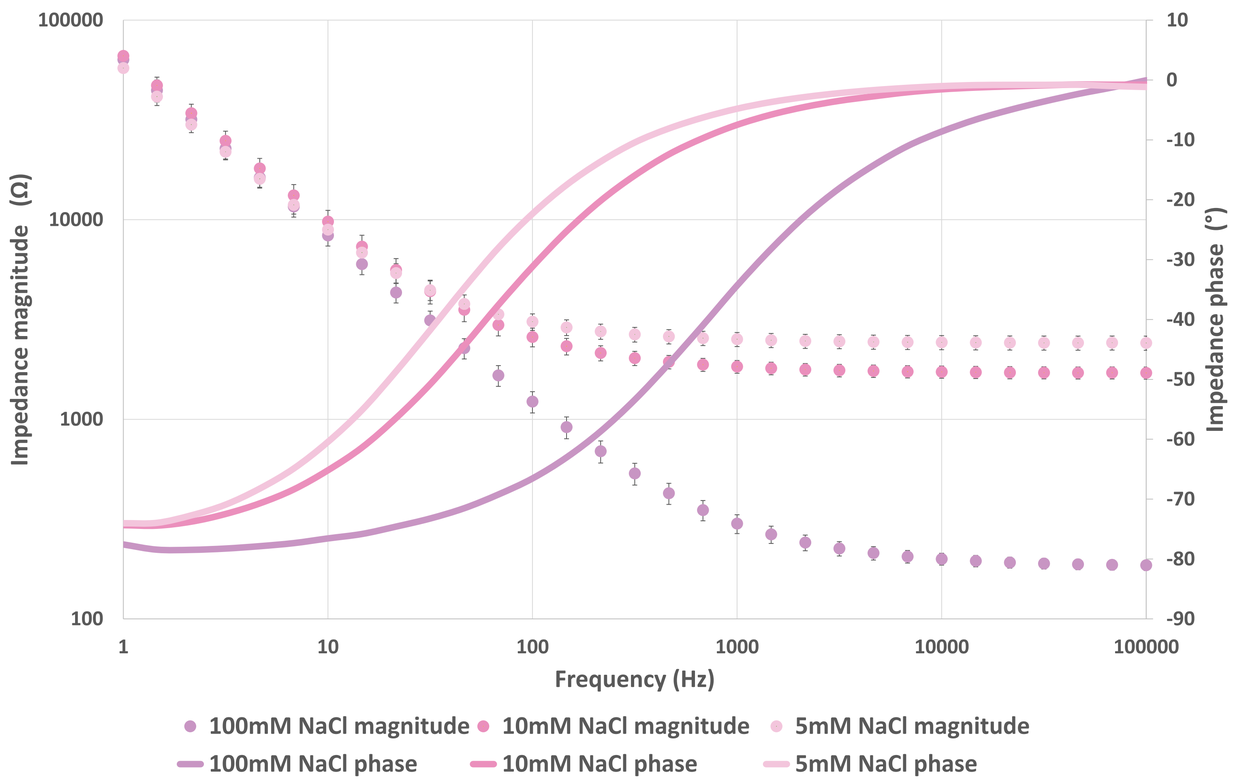
In the first year of the project, HEPIA developed a bio-impedance measurement head recording frequency sweeps from 1 Hz to 100 kHz on 12 samples, measured in pairs. Controlled by software, the system allows for precise control over measurement settings, including sweep mode, frequency points, repetitions, sample count, and time intervals for long-term TEER monitoring. An integrated analyser characterises TEER, electrode deterioration and changes in the medium over time.

Bio-impedance measurement system: hardware and software integration



The measurement head is currently in biological validation. A preliminary test was conducted to verify communication and measure initial resistance using internal components. A conductive solution confirmed its ability to measure in-liquid interface before biological validation, showing expected behaviour in both magnitude and phase with stainless steel rod electrodes. To compare with state-of-the-art systems, a test card with multiple connectors is being developed for evaluation alongside other impedance devices.

Electrical validation of bio-impedance measurement using NaCl solutions



CONCLUSION

Year 1 of 3 :

- ✓ Bio-impedance measurement device 1st prototype
- ✓ Preliminary testing

NEXT STEPS

- Biological validation
- Adaptive lid fabrication
- ILI electrodes optimisation
- ALI electrodes fabrication

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Project funded by Swiss Confederation State Secretariat for Education, Research and Innovation SERI

Co-funded by the European Union Chips JU