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Palacký University
Olomouc



NFC-powered sensors for rapid and real-time precision diagnostics in agriculture and healthcare

José Flauzino & Selin Olenik, 26/03/2025

What is **NFC** (Near Field Communication)?

- Short-range wireless communication technology that allows two devices to exchange data over distances typically **less than 10 cm**.
- It operates at 13.56 MHz.
- Based on electromagnetic induction between two **loop antennas** (similar to RFID).
- Key Features:
 - Short range = high security & low interference.
 - No pairing needed (unlike Bluetooth).
 - Low power consumption.



Why use NFC for sensors?

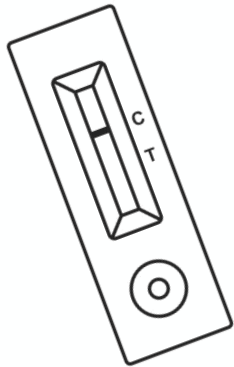
- Wireless power & communication: NFC can both power passive sensors (**no battery needed**) and **read data**.
- Compact & low-cost tags.
- Safe & controlled communication range.
- Integration with **smartphones** for easy readout.
- Scalable, printable electronics (flexible NFC tags).





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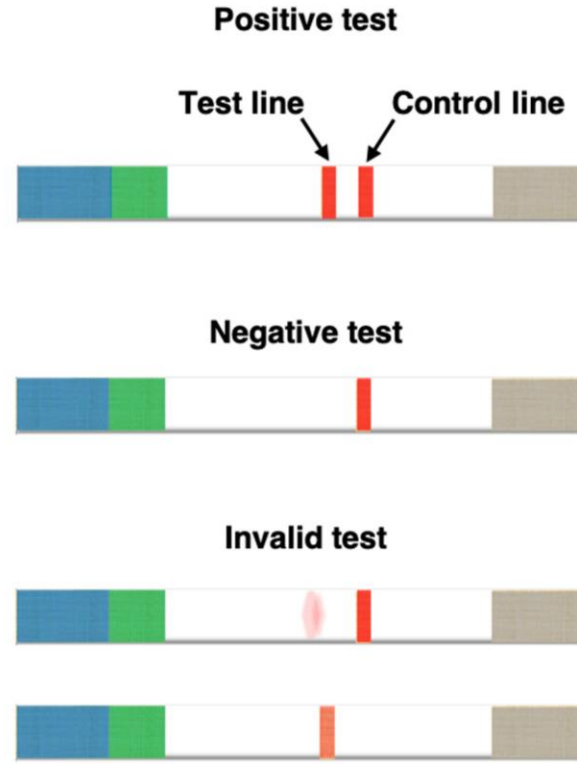
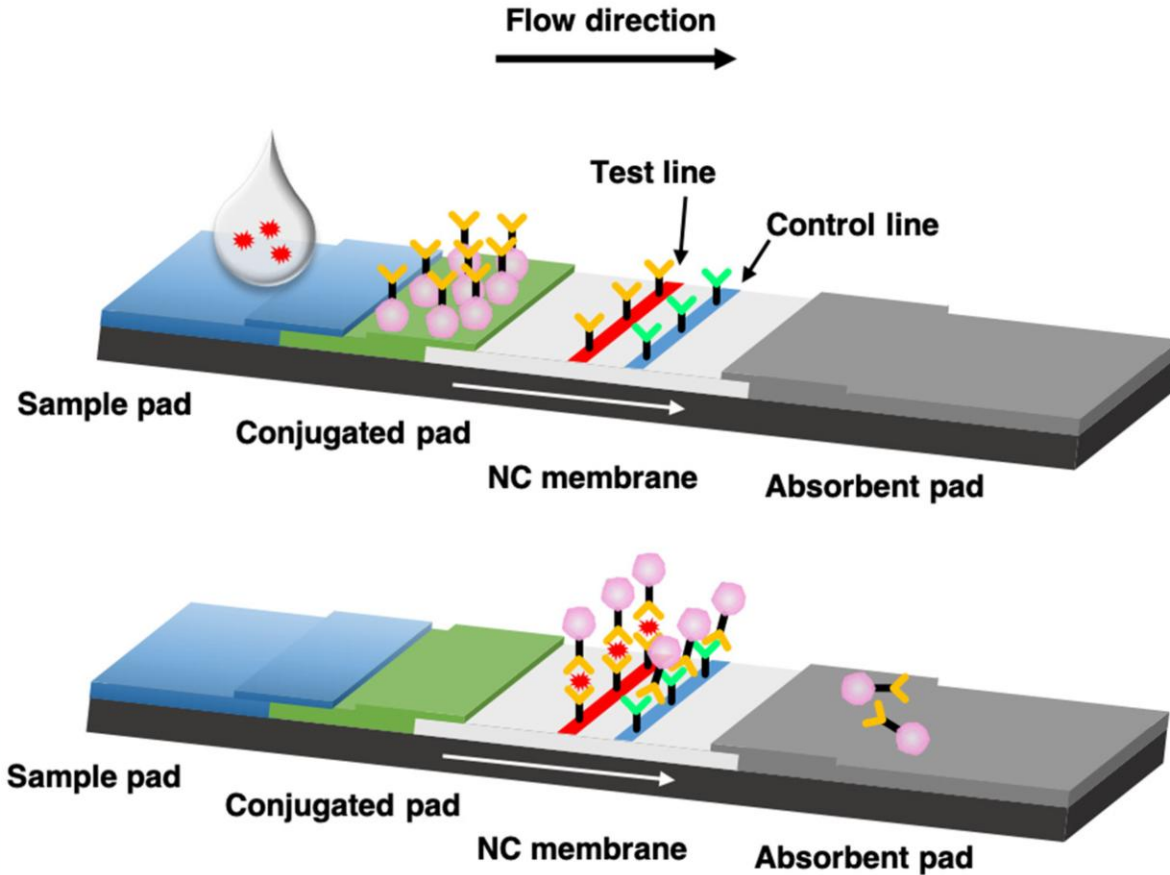
NFC as a tool for the Digitalization of Lateral Flow Assays



José Flauzino, PhD
Güder Research Group
Department of Bioengineering
Imperial College London



Lateral Flow Assay (LFA)



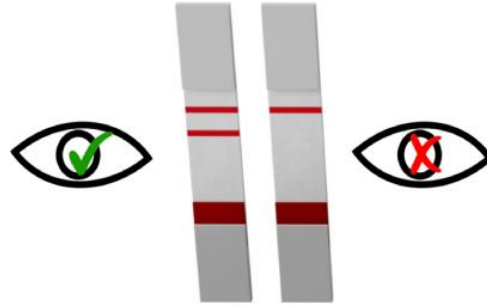
Why LFAs are so widespread?

- **Easy to Use:** No specialized training required
- **Rapid Results:** Results in minutes, perfect for urgent diagnostics.
- **Portable:** Small and lightweight, ideal for fieldwork and remote areas.
- **Versatile Applications:** Used in healthcare (COVID-19, pregnancy tests), agriculture (plant disease detection), and veterinary science.
- **Robust:** Performs well in diverse environments, from labs to farms.
- **Scalable Production:** Can be mass-produced efficiently, making it the go-to solution during outbreaks.



LFA readout methods

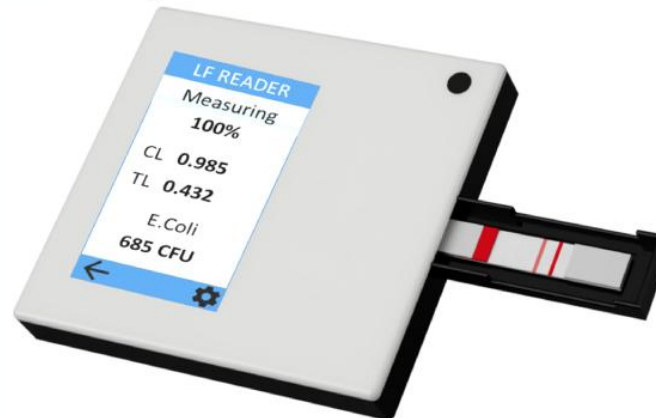
Naked eye qualitative detection



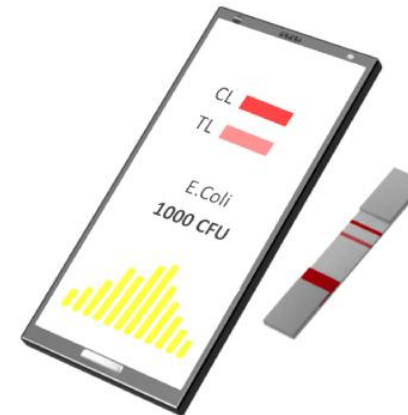
Naked eye semi-quantitative detection

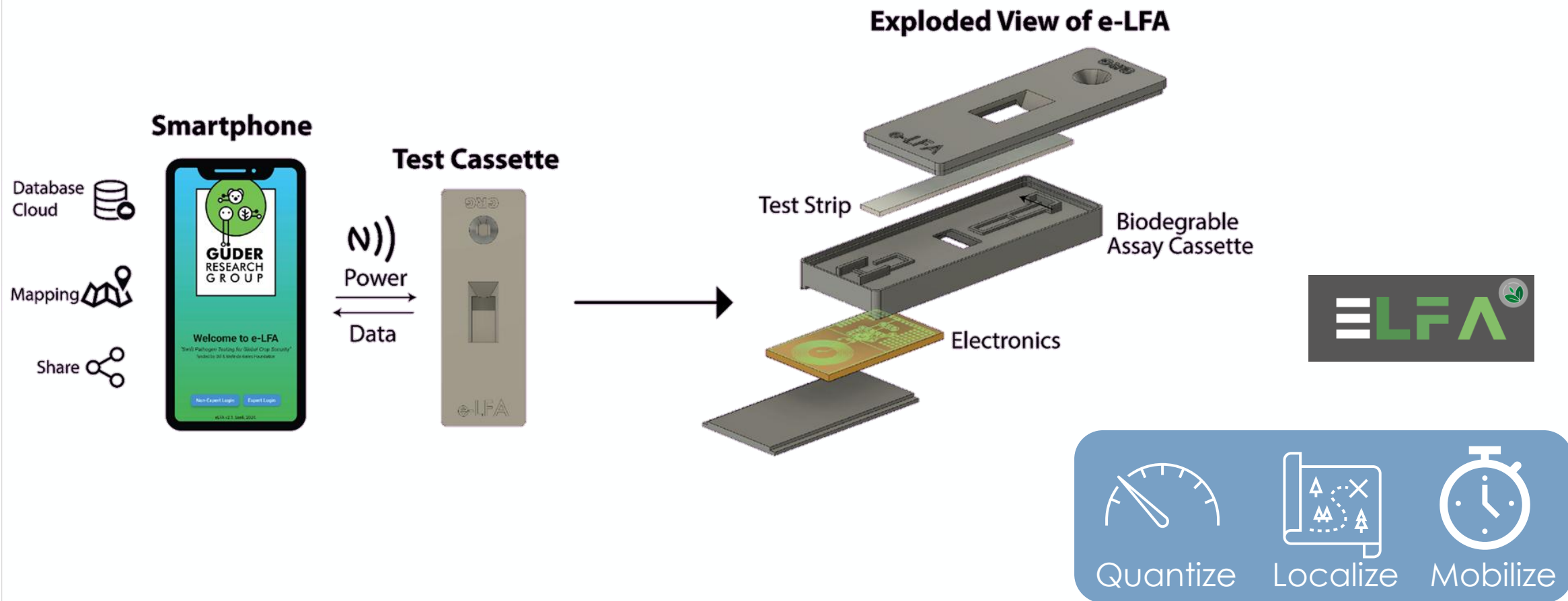


Quantitative detection using a dedicated reader



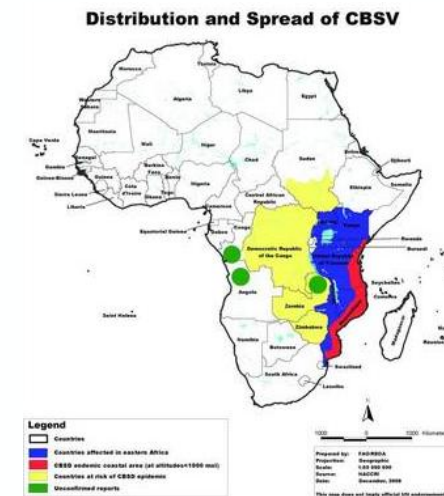
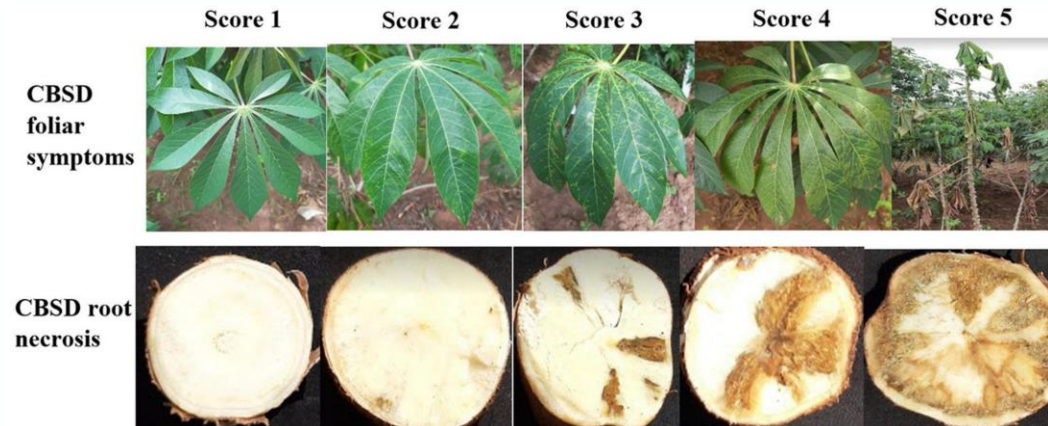
Quantitative detection using a smartphone



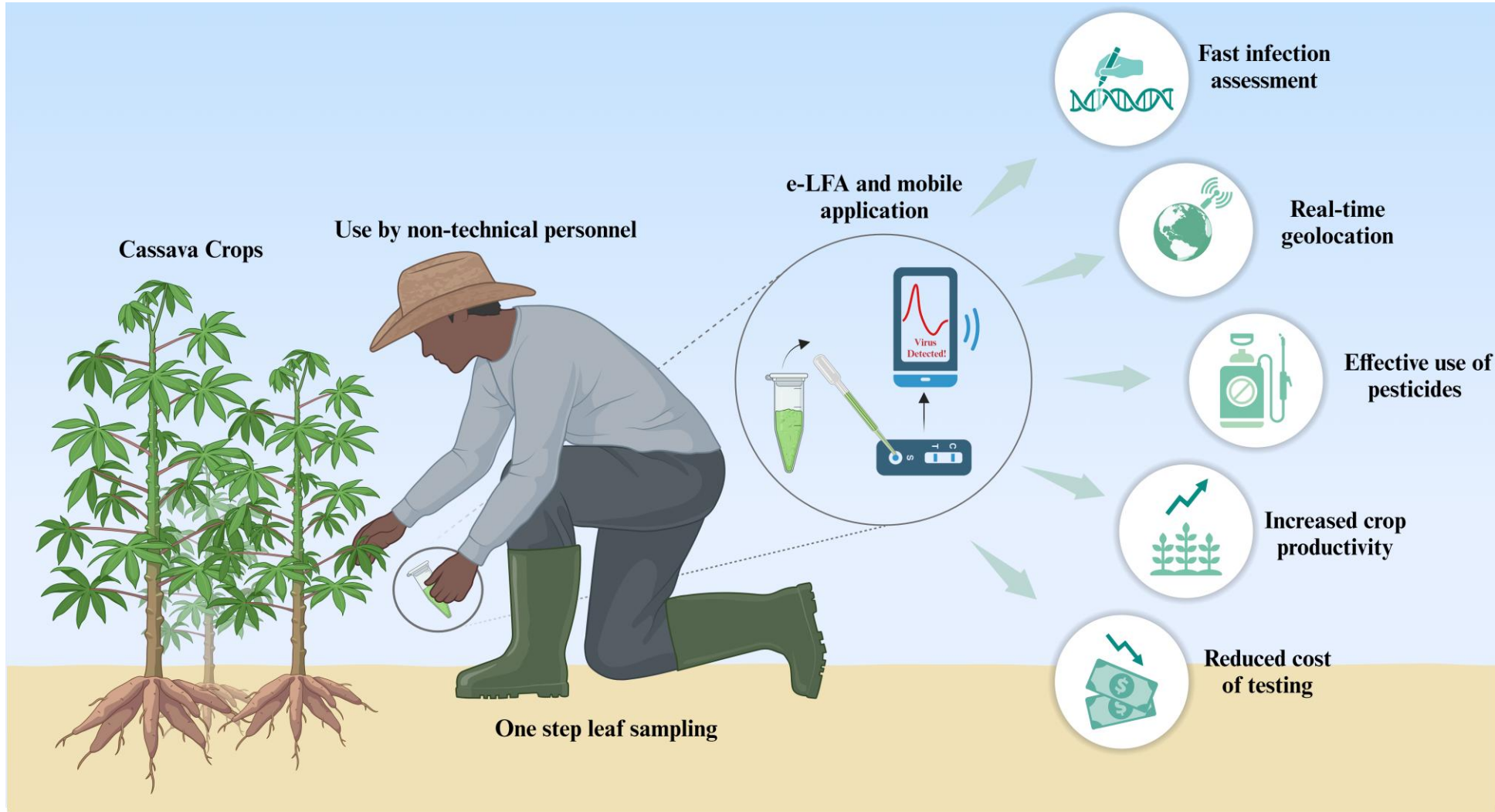


Cassava

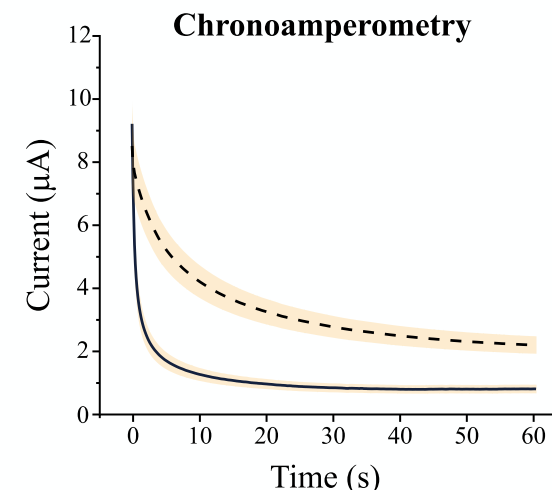
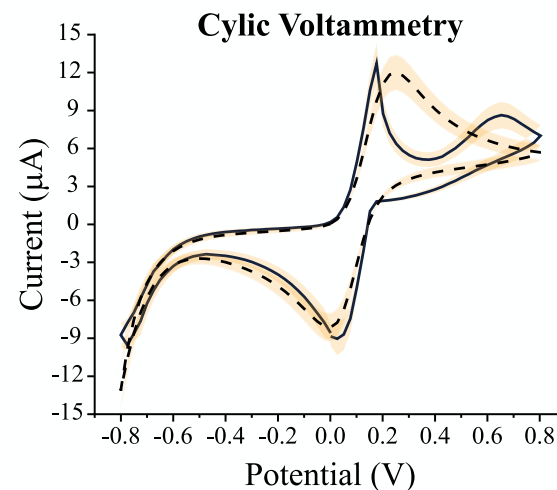
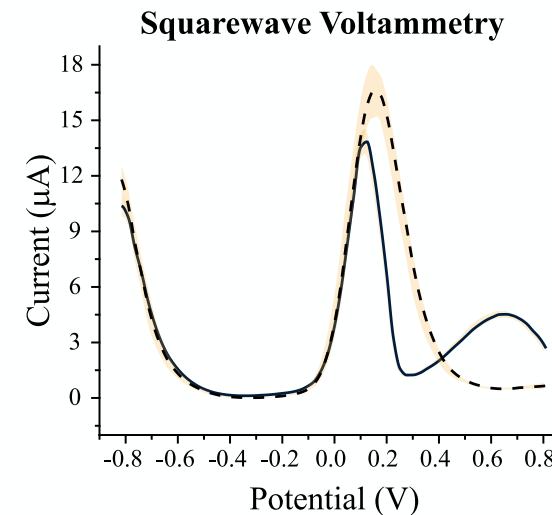
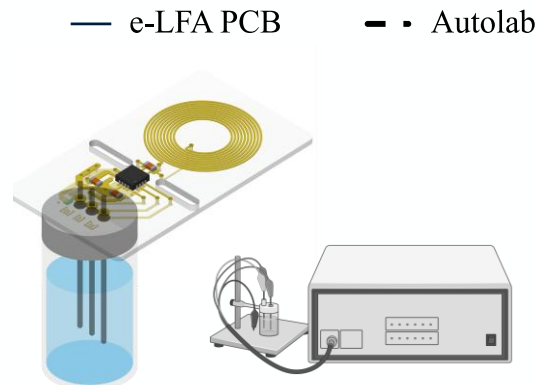
- Staple food for over 800 million people
- Resilient crop in drought-prone areas
- **CBSV** causes root necrosis and yield loss, threatening food security and farmer income
- Widespread in East Africa, West Africa crops are threatened



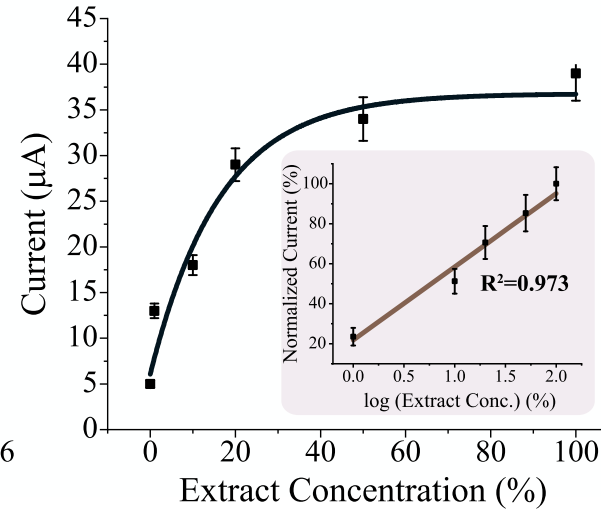
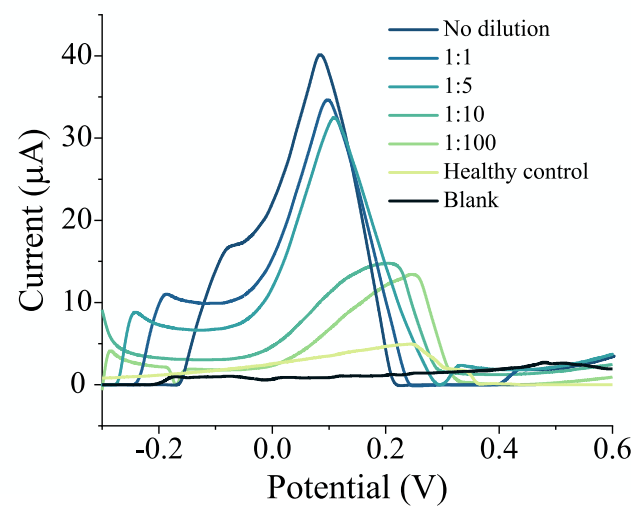
BILL & MELINDA
GATES foundation



Comparison of the NFC system with bench potentiostat



Calibration curve



Funded by the European Union

The work was supported from ERDF/ESF project TECHSCALE (No. CZ.02.01.01/00/22_008/0004587).

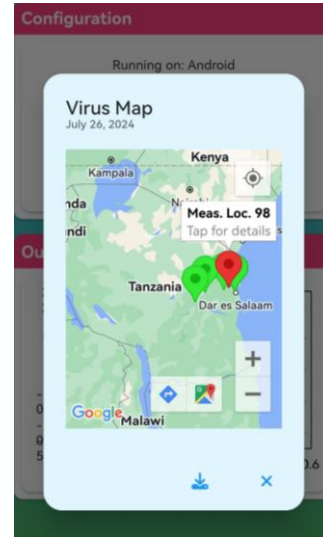
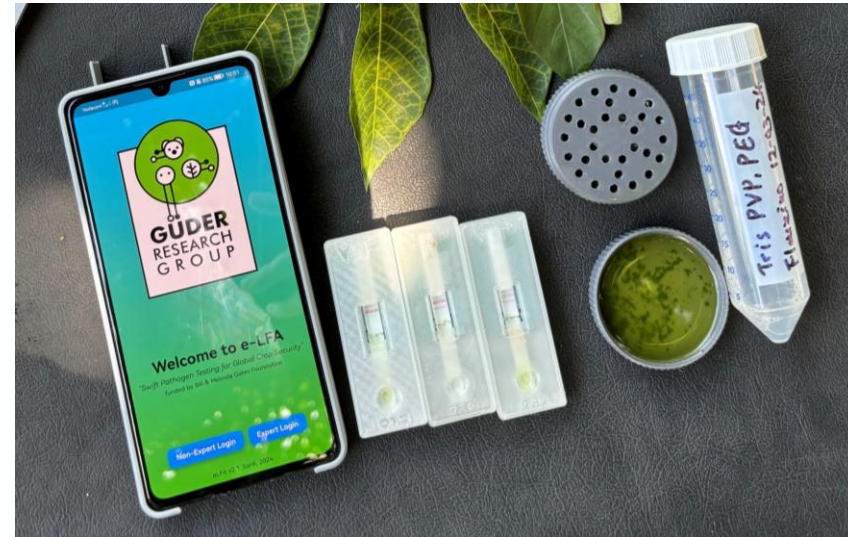


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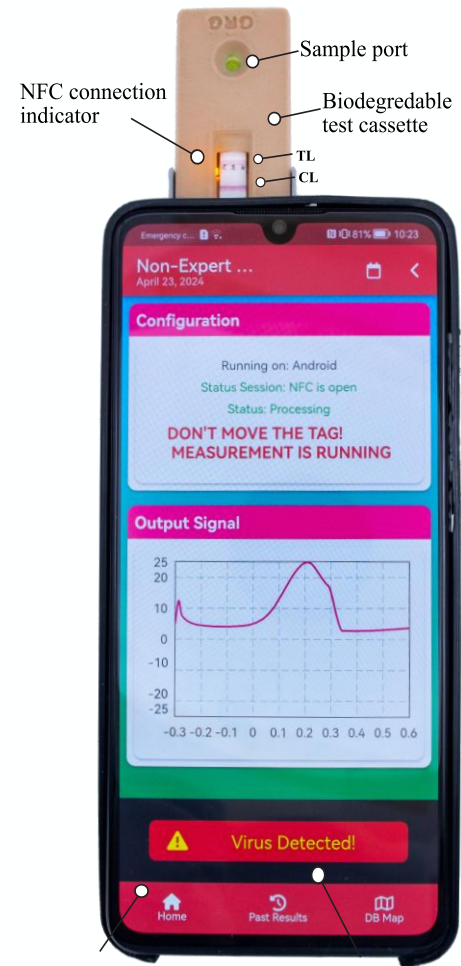
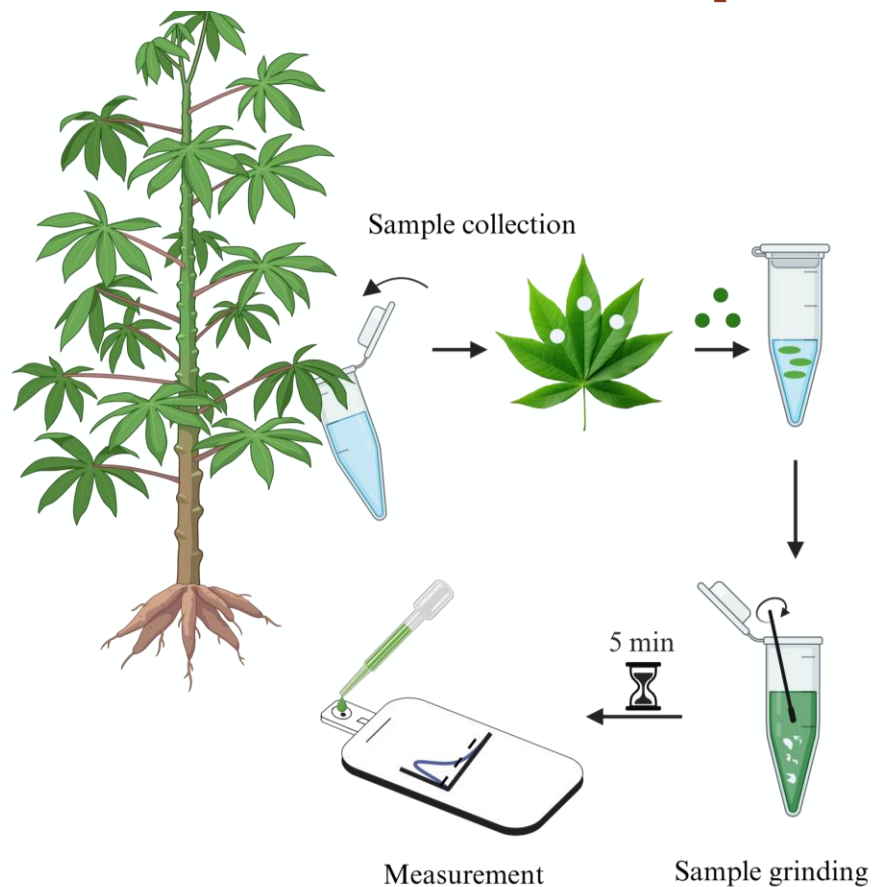




CSI - Cassava Scene Investigation



Comparison with standard methods



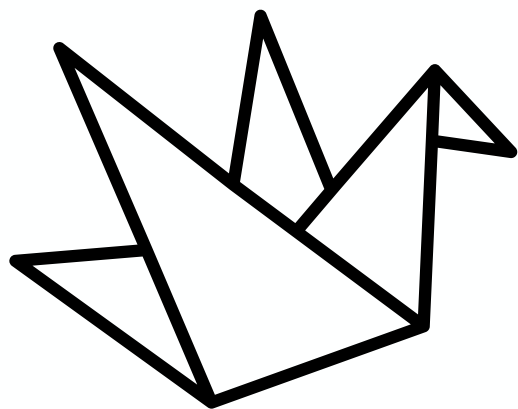
Smart phone (NFC Reader) Custom-made Android app

	e-LFA	ELISA	qPCR
Positive Control	✓	✓	✓
Negative Control	✗	✗	✗
Plant #1	✓	✓	✓
Plant #2	✓	✓	✓
Plant #3	✓	✓	✗
Plant #4	✓	✓	✓
Plant #5	✓	✓	✓
Plant #6	✗	✗	✗
Plant #7	✓	✓	✓
Plant #8	✓	✓	✓
Plant #9	✗	✗	✗
Plant #10	✓	✓	✓

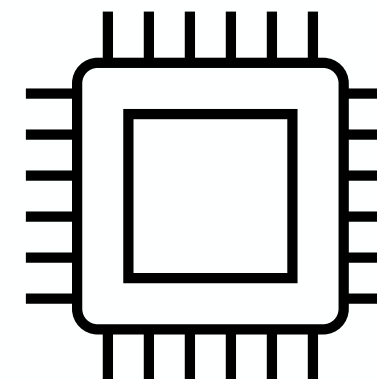


IMPERIAL

Origami-Inspired Minimally Invasive Sensors for Continuous Monitoring



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Güder Research Group
Department of Bioengineering
Imperial College London





Why go UNDERNEATH skin?

SKIN IS A BARRIER



- MOTION ARTEFACTS
- CONTAMINATION
- SKIN PHENOTYPE

SOURCE OF NOISE

- ELECTROLYTES
- METABOLITES
- SOME PROTEINS

RESTRICTIVE

Continuous glucose monitor



Implantable cardiac monitor



Why go UNDERNEATH skin?

SKIN IS A BARRIER

- MOTION ARTEFACTS
- CONTAMINATION
- SKIN PHENOTYPE

SOURCE OF NOISE

- ELECTROLYTES
- METABOLITES
- SOME PROTEINS

RESTRICTIVE

↑ Infection

↑ Recovery time

↑ Financial burden



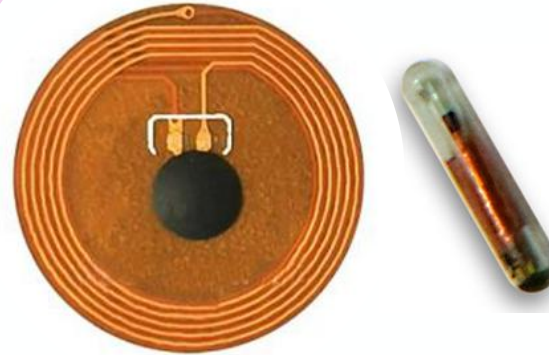


Near Field Communication

Wireless communication

Battery-less operation

Standardized protocol



NFC: 13.56 MHz

Wireless communication

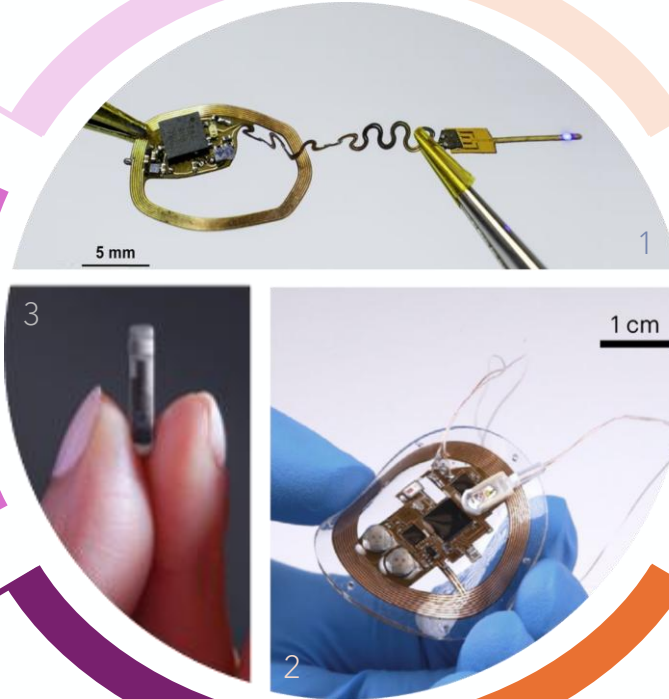
Neuro-monitoring

Battery-less operation

Cardiac monitoring

Standardized protocol

Glucose monitoring



1 - Burton et al., *PNAS*, 2020, 2 - Kwon et al., *Nat. Biomed. Eng.*, 2023, 3 - Eversense CGM



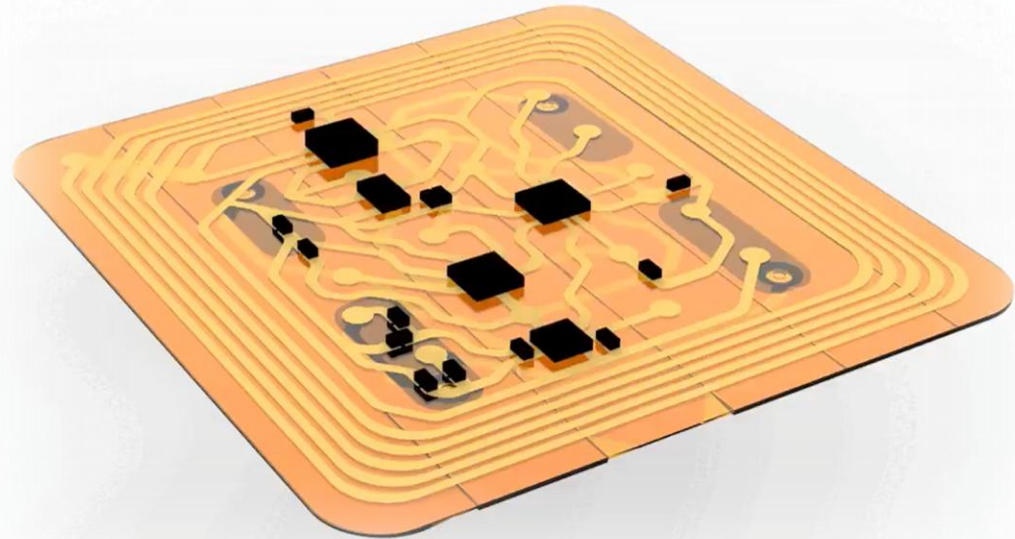
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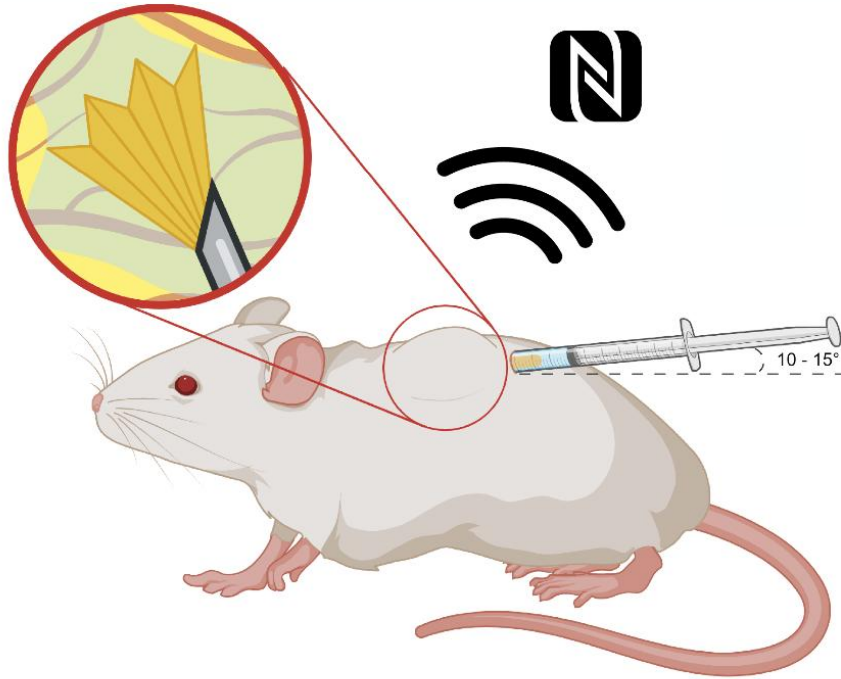


+ POWER

+ VERSATILITY

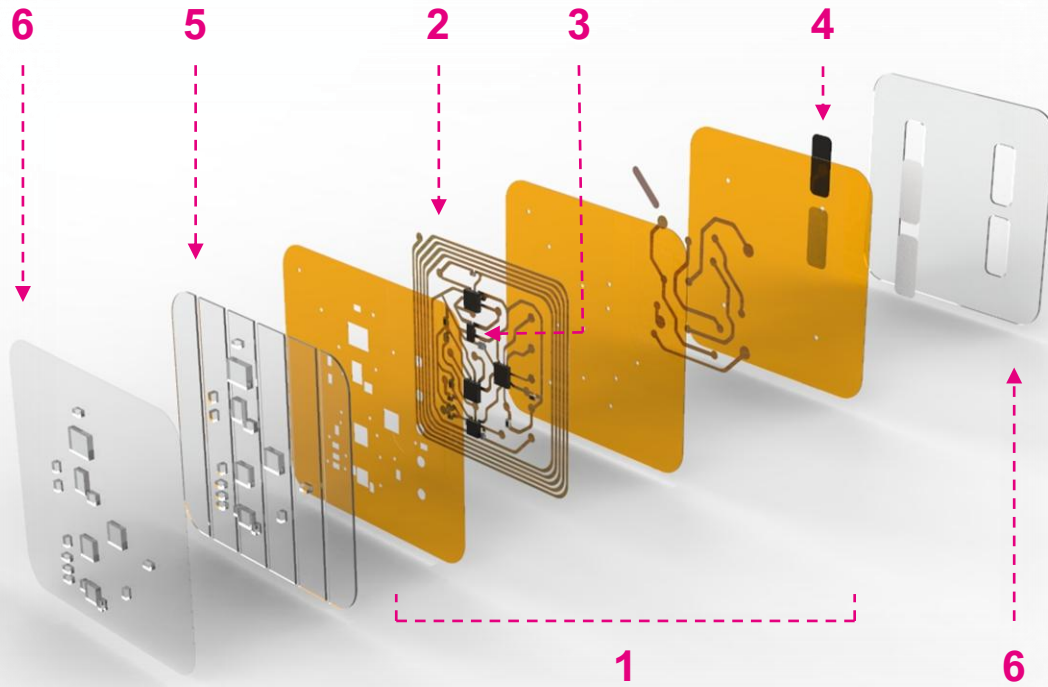
+ COMPACTNESS





- ✓ **6x smaller**
- ✓ **3mm incision**
- ✓ **Automatic unfolding**
- ✓ **Outpatient procedure**

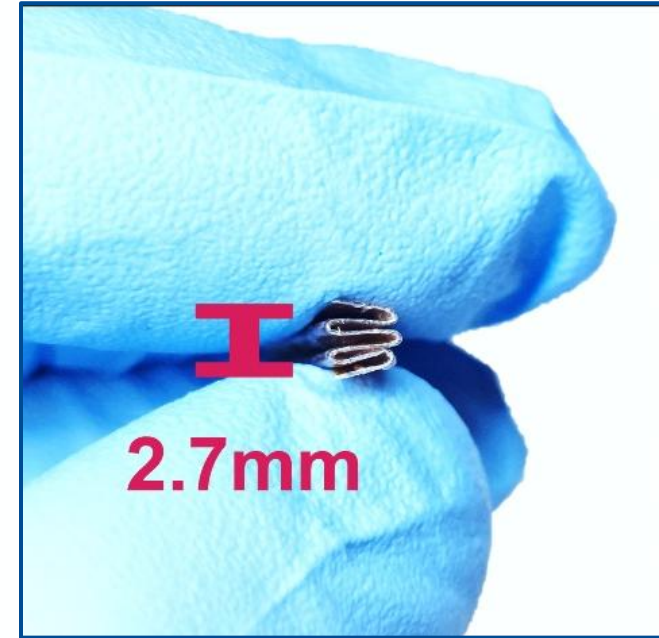
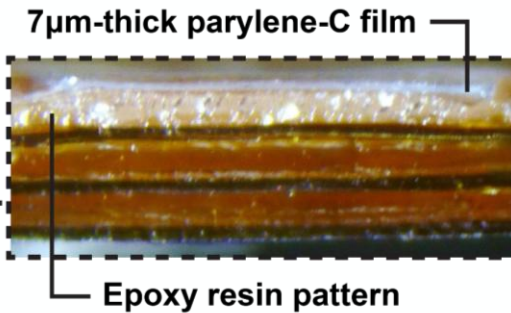
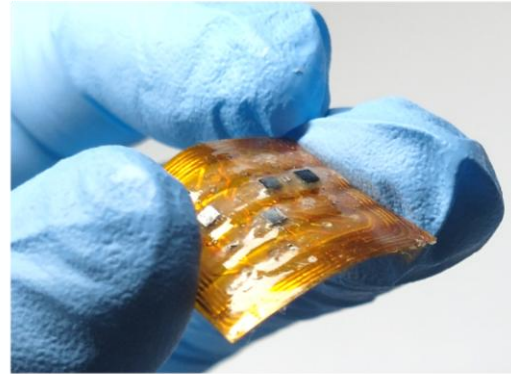
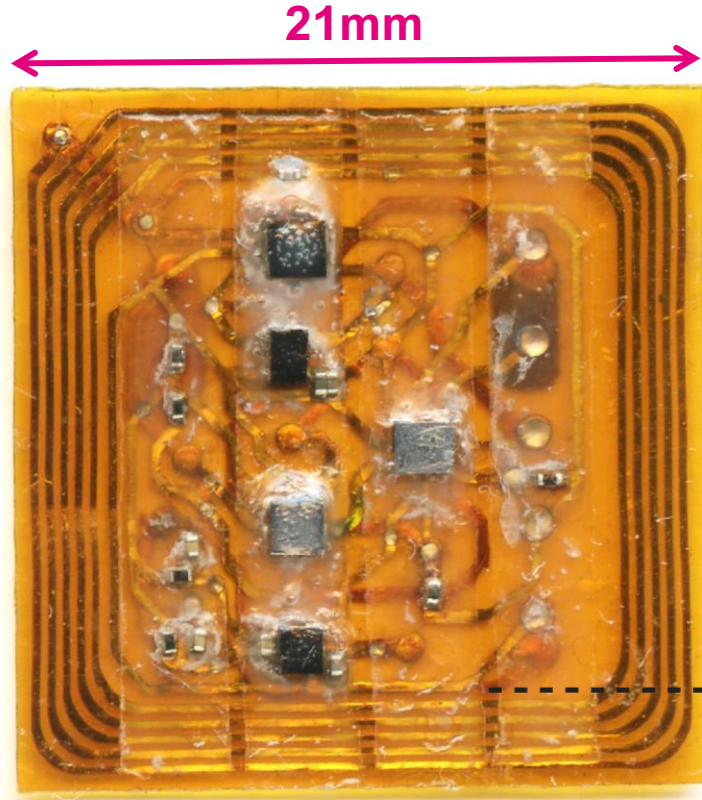




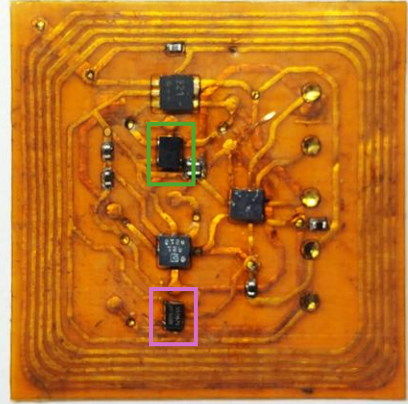
1. Flexible and bendable circuit board
2. NFC planar antenna
3. Off-the-shelf ICs
4. Analog sensing electrodes
5. Patterned epoxy resin fold guides
6. μ -scale Parylene-C encapsulation



Device encapsulation

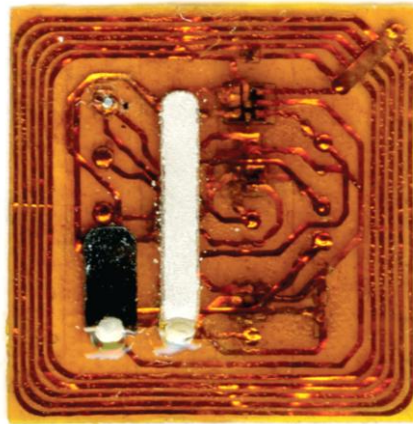
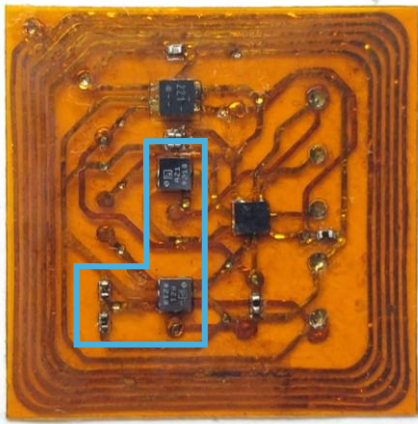


V1



- **Subcutaneous temperature**
- **Heart rate**
- **Breathing rate**

V2



- **ISF ion activity**
 - **Lithium**
 - **(Sodium, potassium, etc...)**

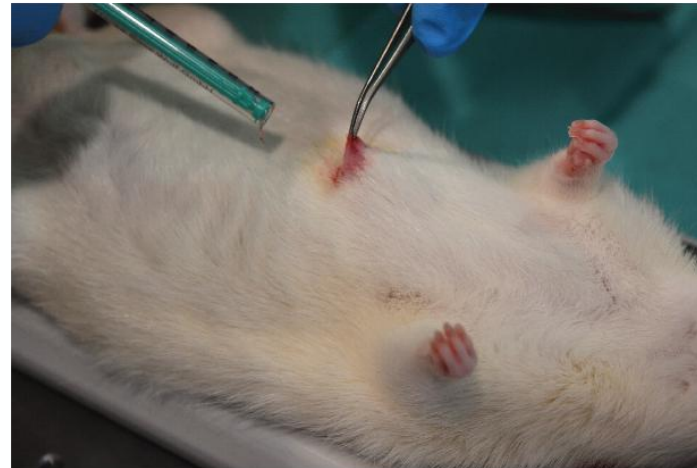


Subcutaneous implantation

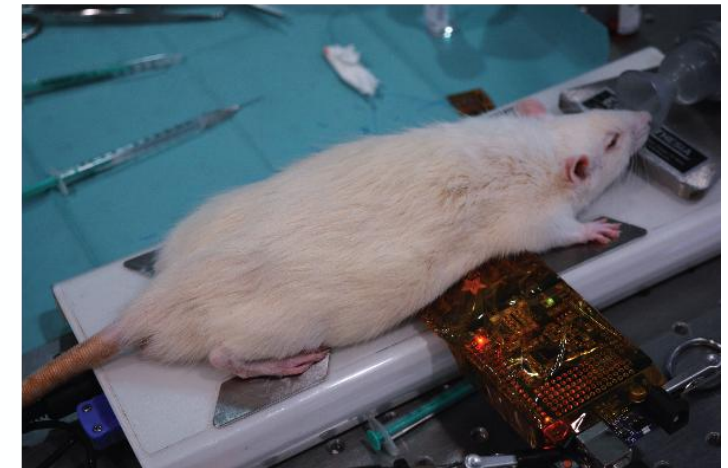
1. Inject device into space



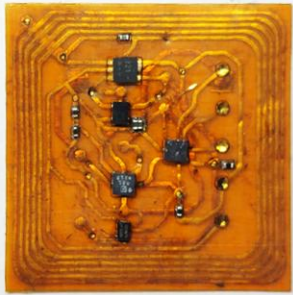
2. Let device unfold



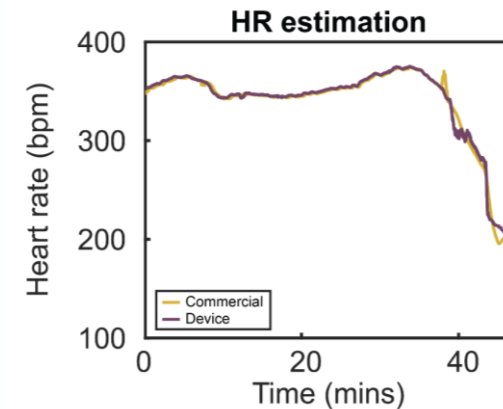
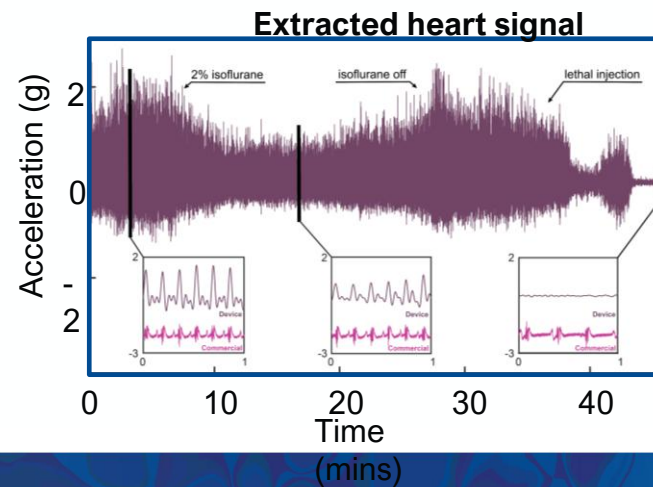
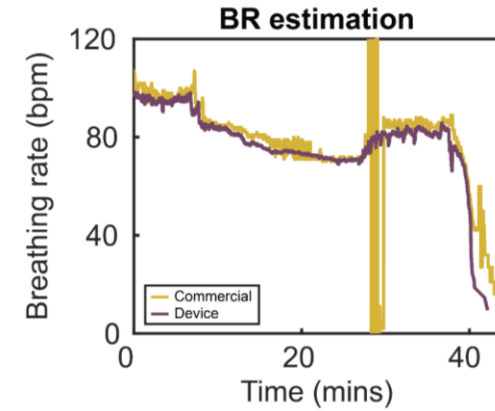
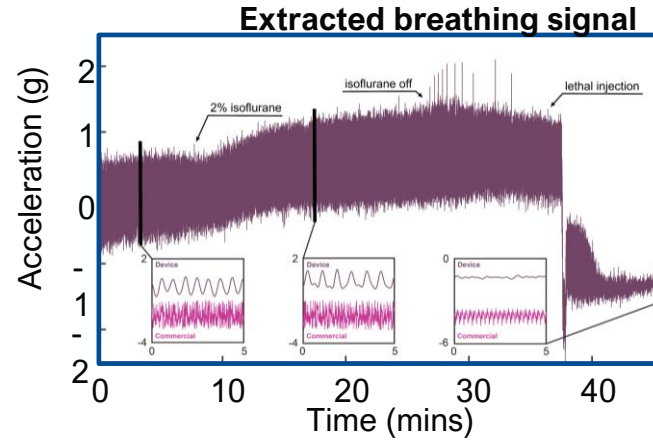
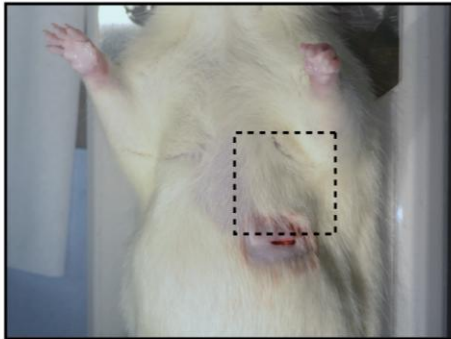
Continuous monitoring setup



V1: in vivo monitoring



Implantation site



Further applications



**FASTER
RECOVERY**



**HIGHER QUALITY
TREATMENT**



**EASIER
ACCESS**



THE ROYAL SOCIETY

Innovate UK



Institute for Security Science and Technology



ANALYTICAL CHEMISTRY TRUST FUND



BILL & MELINDA GATES foundation



HORIZON EUROPE



Research England

EPSRC



cytiva

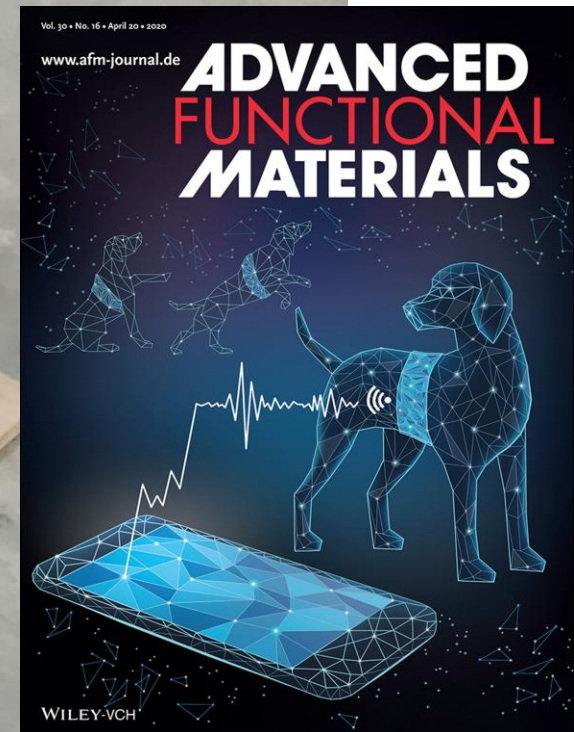
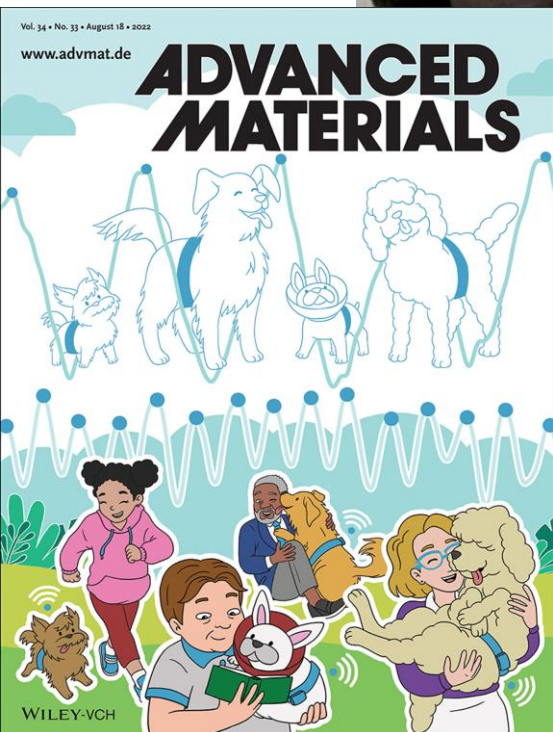


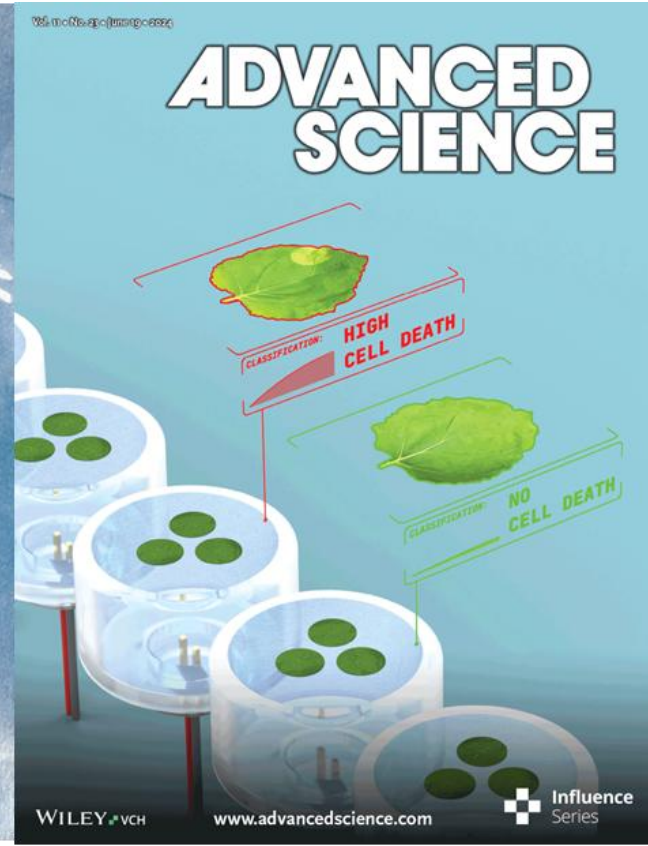
DFG Deutsche Forschungsgemeinschaft



Health

Special thanks to organizers of the Spring School







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April 2024

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