**Co-design of a four-chip NFC system and microfluidic channel for point-of-care electrochemical sensing**

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Fast, on-site chemical sensing is essential for various applications, including point-of-care analyses that can exploit NFC communications for ease of use with commercial smartphones. Here, we report the layout design of a novel four-chip NFC system integrated with microfluidics for electrochemical sensing, enabling simultaneous analysis of up to four chemical species. Last-generation commercial-off-the-shelf NFC boards capable of performing open circuit potentiometry are utilized. However, based on the microfluidic circuit, more liquid samples may be required, hindering measurement accuracy. On the other hand, the arrangement of the commercial-off-the-shelf NFC boards themselves must adapt to the channel's shape to minimize liquid losses and avoid eventual interferences between the boards. Hence, three layouts of the NFC-microfluidic system are initially considered, and the best one was experimentally selected to optimize i) the amplitude of the read areas, ii) the communication quality, quantified by passive load modulation, and iii) the number of liquid samples required by the microfluidic. The selected system layout is finally validated by quantifying sodium in a standard solution, showing promising results. The resulting system can be used multiple times by simply changing the sensing electrodes and the low-cost, paper-based microfluidic. Ongoing work includes optimizing the microfluidic circuit for blood sensing and testing the system in clinical settings by integrating all the components into an ad-hoc 3D-printed case.

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# Abstract 11

## ROME TECHNOPOLE Flagship Project 7

### Research line FP7.GL3

**Biosensor, Biomarkers, Innovative Medical Device Development and Bio-active Molecules for Biopharmaceutical/Nutraceutical Products**

Next-gen Point of Cares: *Chemical-Physical Sensors with Wireless Interface for Health Monitoring in Domestic Settings*

- Dr Bianco, Giulio Maria, *University of Rome Tor Vergata, RTD-A*
- PI: Prof. Occhiuzzi, Cecilia, *email*: cecilia.occhiuzzi@uniroma2.it
- Aims of the research: develop wireless sensors for real-time health monitoring at home by utilizing UHF-RFID/NFC interfaces

*Research team of the Pervasive Electromagnetics Lab*


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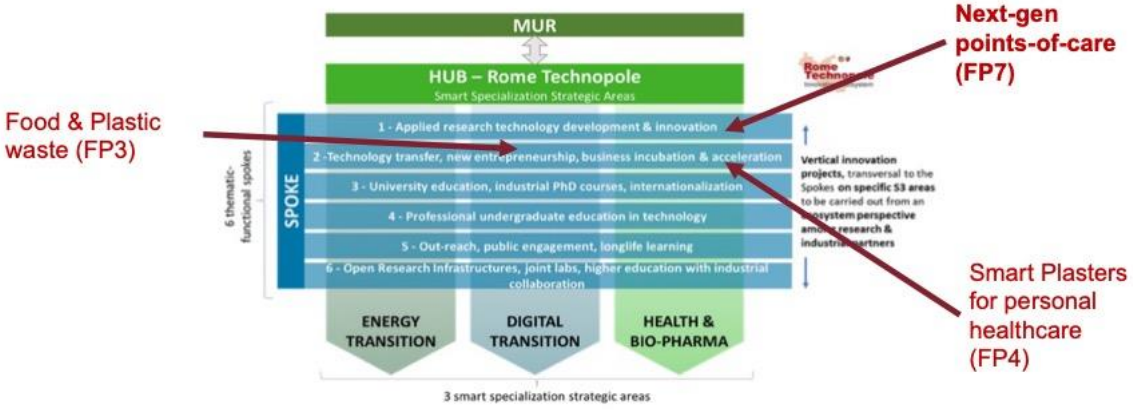
## LEP Rome Technopole Research: Three Lines

http://www.pervasive.ing.uniroma2.it/RomeTechnopole.htm

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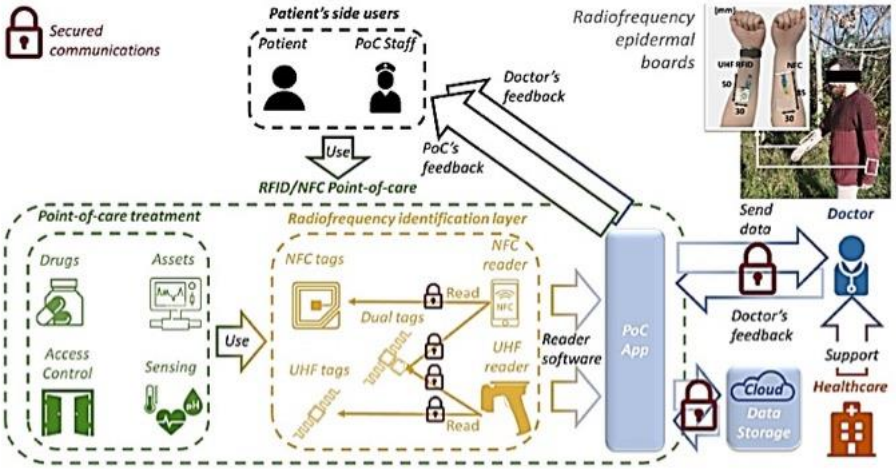
## Starting Point: RFID and/or NFC for PoC

http://pervasive.ing.uniroma2.it/e_crome.htm

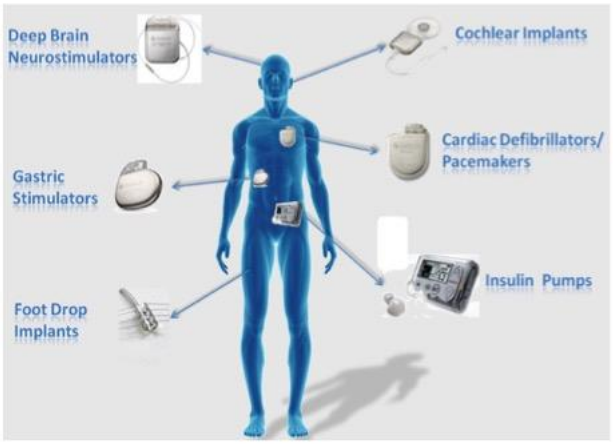





## Issues: Detection of Multiple Analytes & (Cyber)Security of Medical Data

Health data collected **must not** be *visualized or modified* by external agents.

- Physical attacks to the EM link.
- Cyber attacks to data.
- Extreme sensitivity of medical data.
- Evolving privacy regulation



## Four-Chip NFC Potentiostat for Analytes' Quantification

- Solution: secure telemonitoring can be achieved by merging NFC chemical sensing with emerging standard FHIR.
- A ***multi-chip NFC system*** would allow for sensing multiple chemical species.


*On-site chemical sensing of blood by NFC and microfluidics.*


*State-of-the-art commercial NFC potentiostats.*

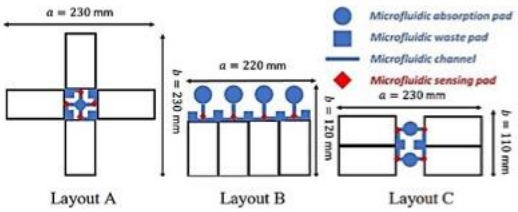


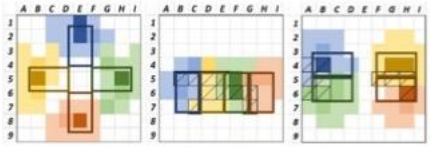
## Considered and Evaluated System Layouts

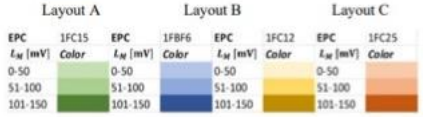
NFC potentiostats: COTS FlexSense SIC 4343 (by SiliconCraft Technologies).

Microfluidic channels ***co-designed with system layout*** to maximize chemical accuracy.

Coverage maps experimentally measured.



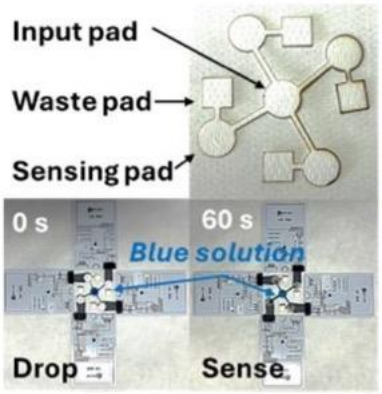



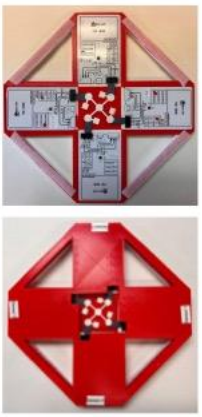
## Final System Assembly and Prototypation

Layout A (cross of boards) returned the optimal compromise between communication and number of required samples.

Paper-based microfluidic tested by *Molybdenum Blue* solution.

**3D-printed** protective case.





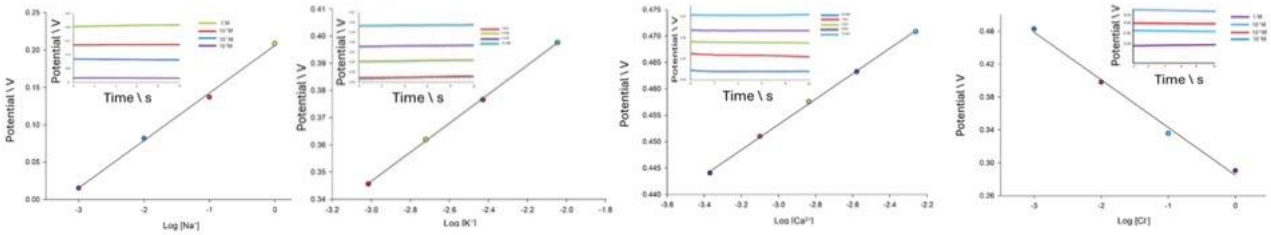
## System Calibration

**Calibration** is needed for sensing via smartphone.

*Na, K, Ca, Cl ions selected.*

Stable response of the system confirmed.

**Full sensing in 60 seconds!**



## Conclusion and Ongoing Work

The first multi-chip NFC system for chemical sensing was designed and calibrated.

The system serves PoC purposes, but also *on-site food quality* testing preventing illnesses.

**Ongoing work:** clinical tests involving oncology patients.

***Blood sample from on-site test***