

Real-time Sweat Analysis: Concept and Development of an Autonomous Wearable Micro-fluidic Platform

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OUTLINE

- Sweat, why is it Important?
- Introduction: Wearable Sensors
- Fabrication and Characterisation of the Devices
- Results
- Conclusions

INTRODUCTION



SWEAT, WHY IS IT IMPORTANT?

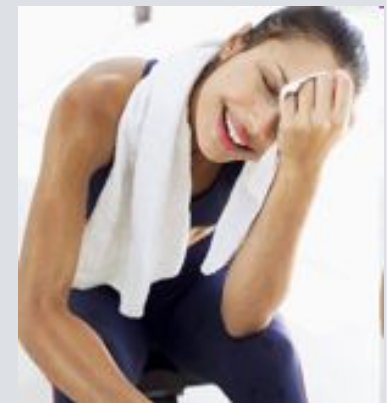
Sweat is naturally generated during exercise.

Monitoring its contents provides very rich information about the physiological condition of the individual.

Rehydration and re-mineralisation



Improve performance and general health



Sweat analysis: identify pathological disorders

- ✧ Cystic fibrosis*
- ✧ Information on dehydration
- ✧ Changes in the concentration of biomolecules and ions
- ✧ Hyponatremia (low sodium concentration)

*Common hereditary disease which affects the entire body, causing progressive disability and often early death.

PHYSIOLOGICAL & CHEMICAL SENSORS

LIFESHIRT®



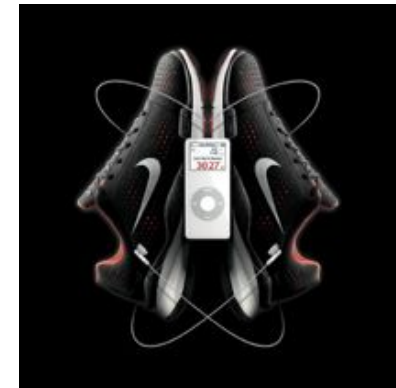
- ✓ Breath rate,
- ✓ Heart rate,
- ✓ Posture
- ✓ Skin temperature
- ✓ ...



Medtronic Diabetes' Guardian®



NIKE-APPLE IPOD Sports Kit®



Lactate Scout®

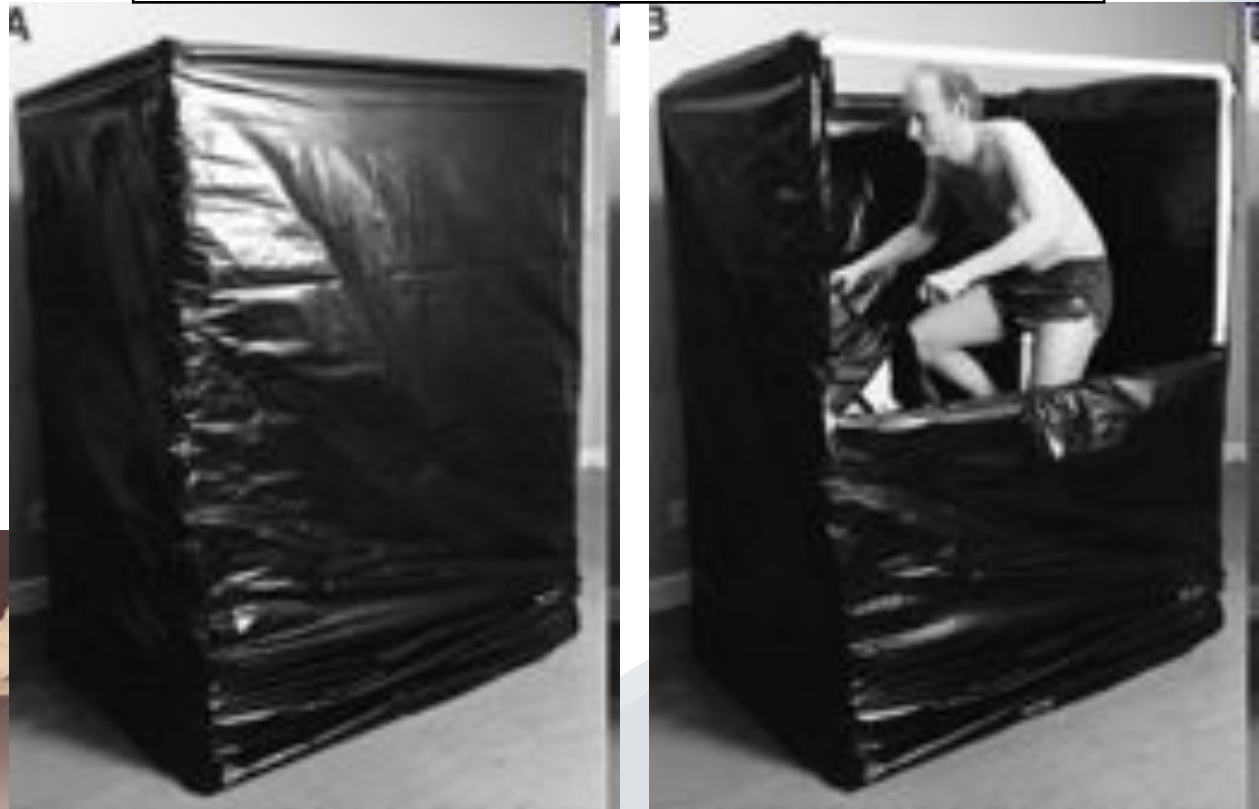
SWEAT ANALYSIS

Macroduct sweat collection system



PharmChek Sweat Patch

Whole body sweat collection techniques



S. M. Shirreffs and R. J. Maughan, J Appl Physiol 82: 336-341, 1997

REAL-TIME SWEAT ANALYSIS

WHAT DO WE NEED????

DEVICE:

WEARABLE

ROBUST

FLEXIBLE / ADAPTABLE

REUSABLE / DISPOSABLE (CHEAP)

IMMEDIATE FEEDBACK

DETECTION:

NOT INVASIVE

WIRELESS

FREEDOM FROM ELECTRONIC NOISE

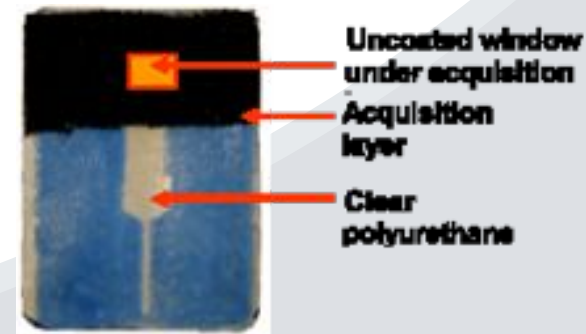
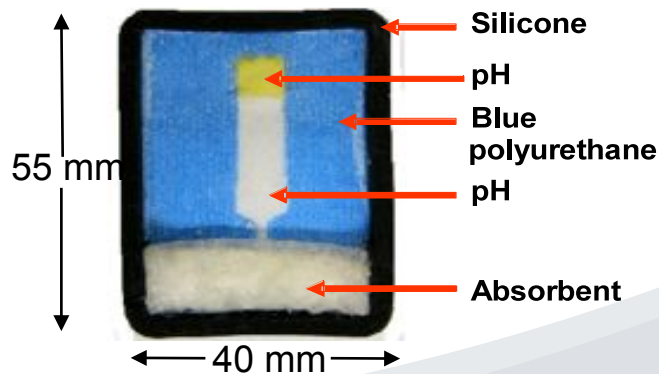
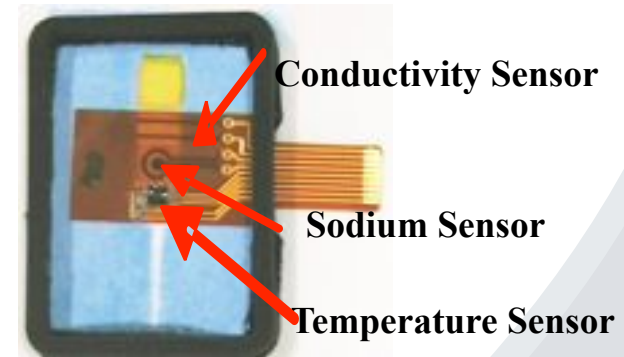
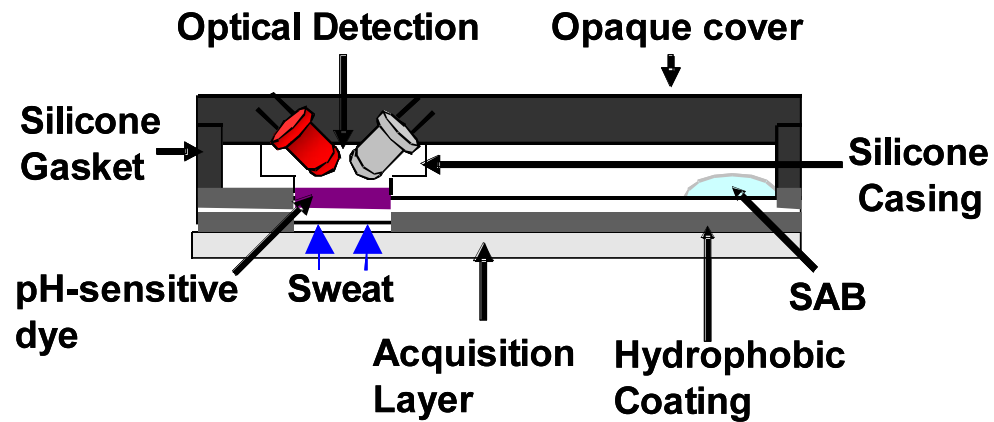
MINIATURIZATION

FLEXIBILITY IN INTERROGATION APPROACHES
(human eyes, LED-sensors, cameras, spectrometers, ...)

MICRO-DEVICES!!

OPTICAL SENSORS!!

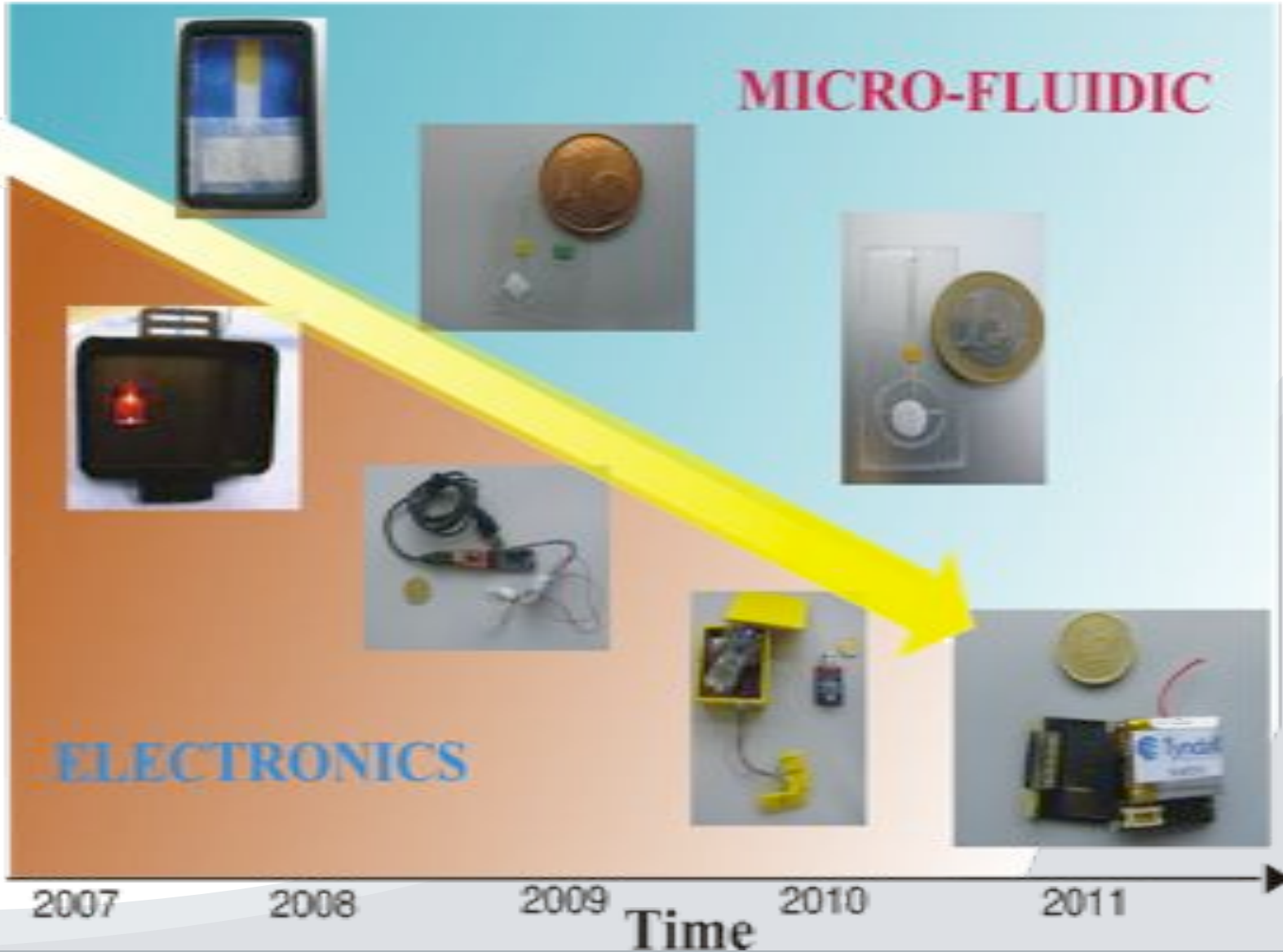
BIOTEX – Biosensing Textile for Health Management



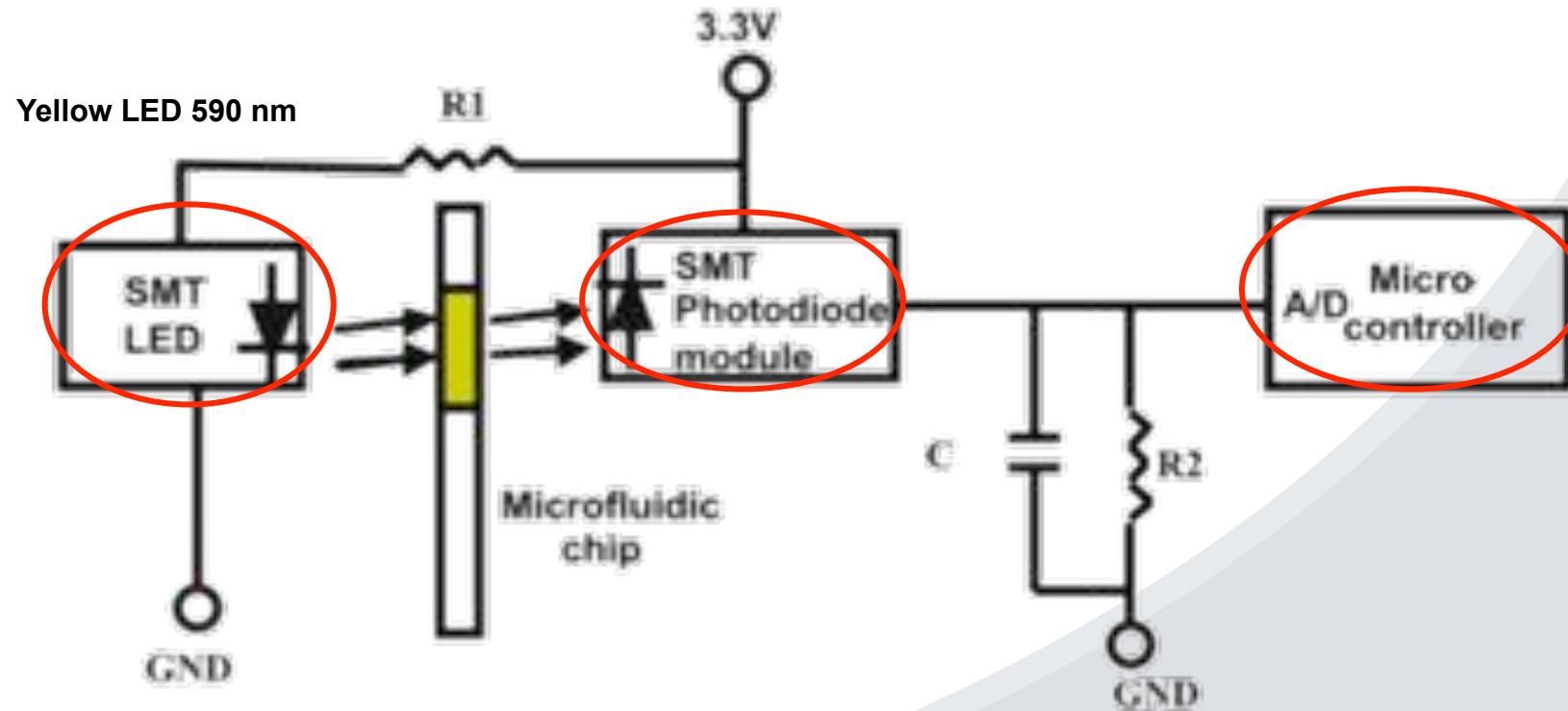
www.biotex-eu.com

S. Coyle, IEEE Transactions on Information Technology In Biomedicine, VOL. 14, No. 2, MARCH 2010

DEVELOPMENT OF THE CONCEPT



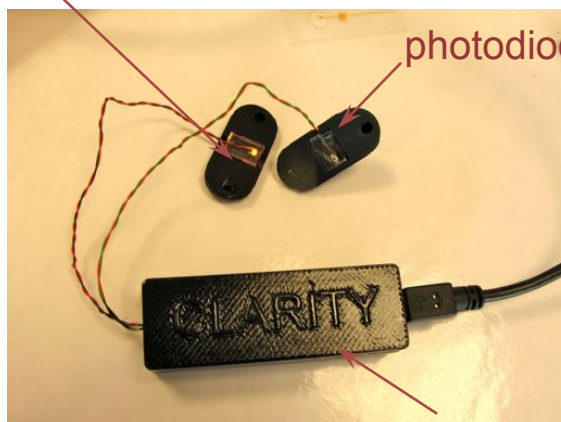
OPTICAL DETECTION



DETECTORS

Wired detector

smLED

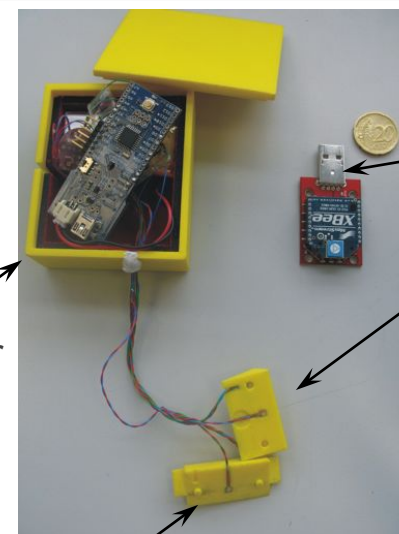


photodiode

Microcontroller

Wireless detector

- ✓ Microcontroller
- ✓ Battery Pack
- ✓ Transmitter



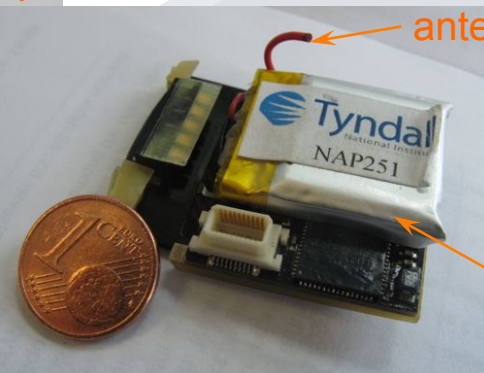
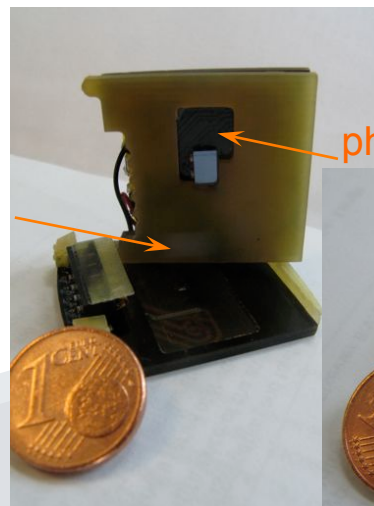
radio receiver

photodiode

smLED

smLED

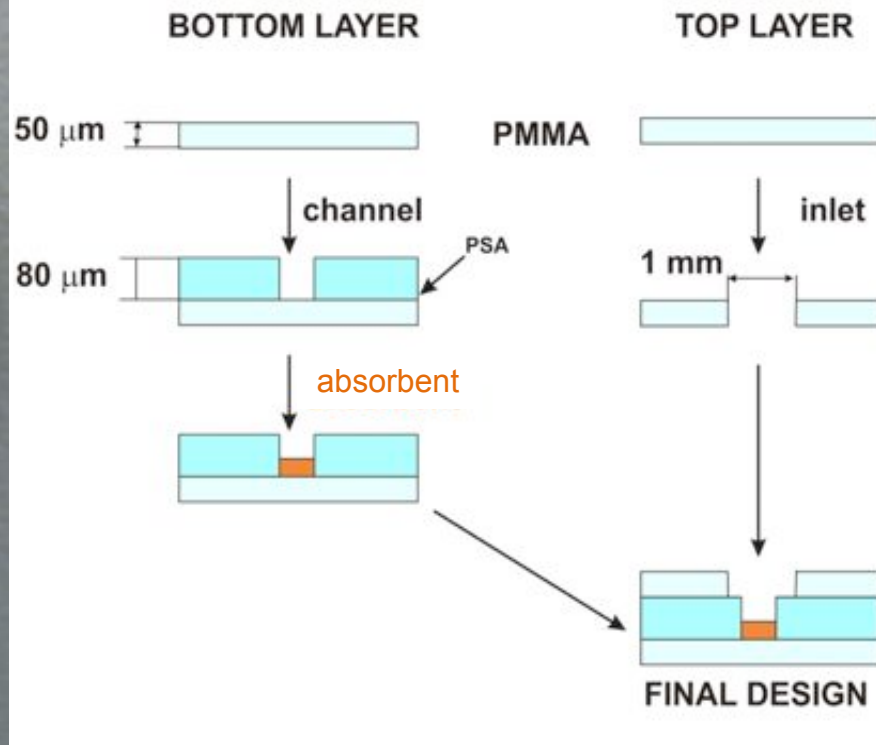
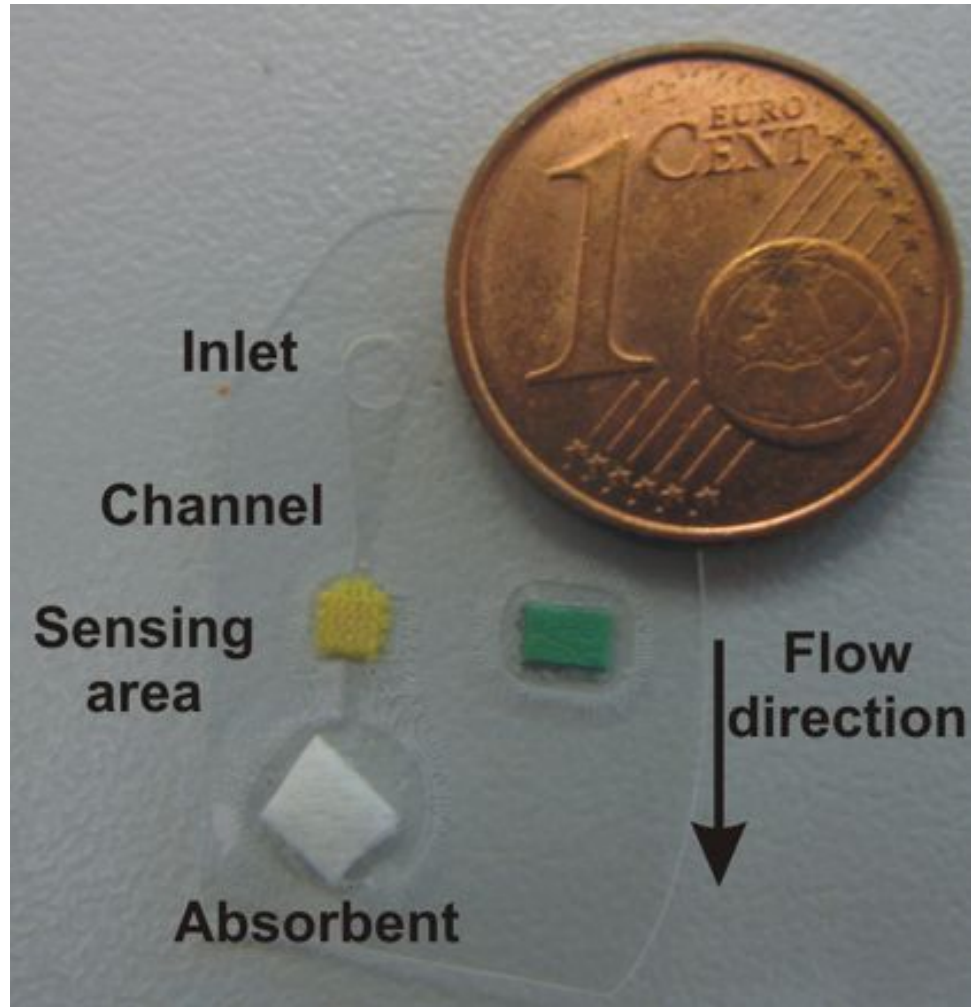
Portable detector



antenna

- ✓ Microcontroller
- ✓ Battery Pack

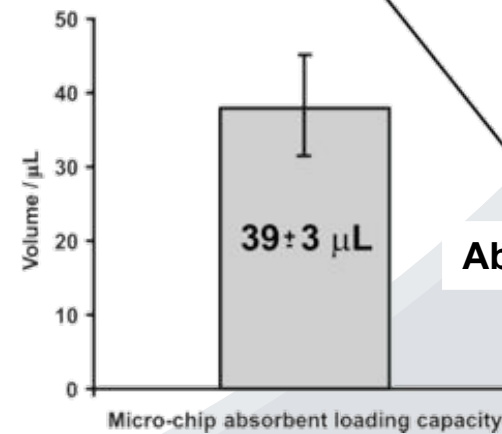
MICRO-DEVICE: Fabrication



Main Characteristics:

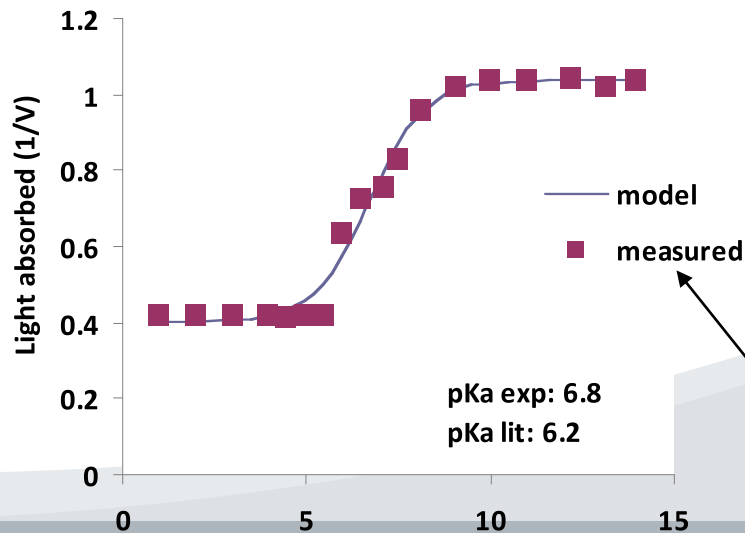
- pH dye bromocresol purple
- Absorbent = passive pump

MICRO-DEVICE: Characterisation



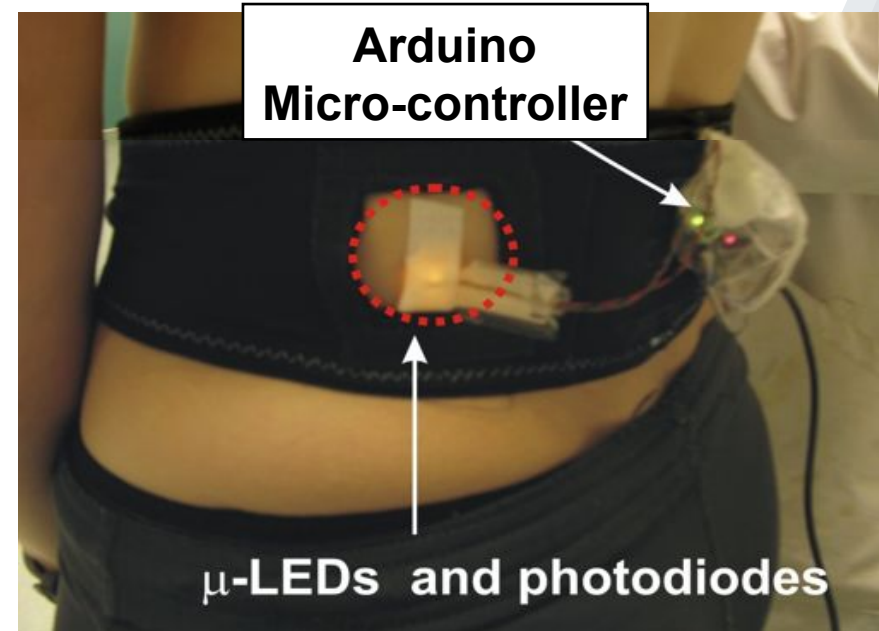
Absorbent

Loading capacity of the absorbent

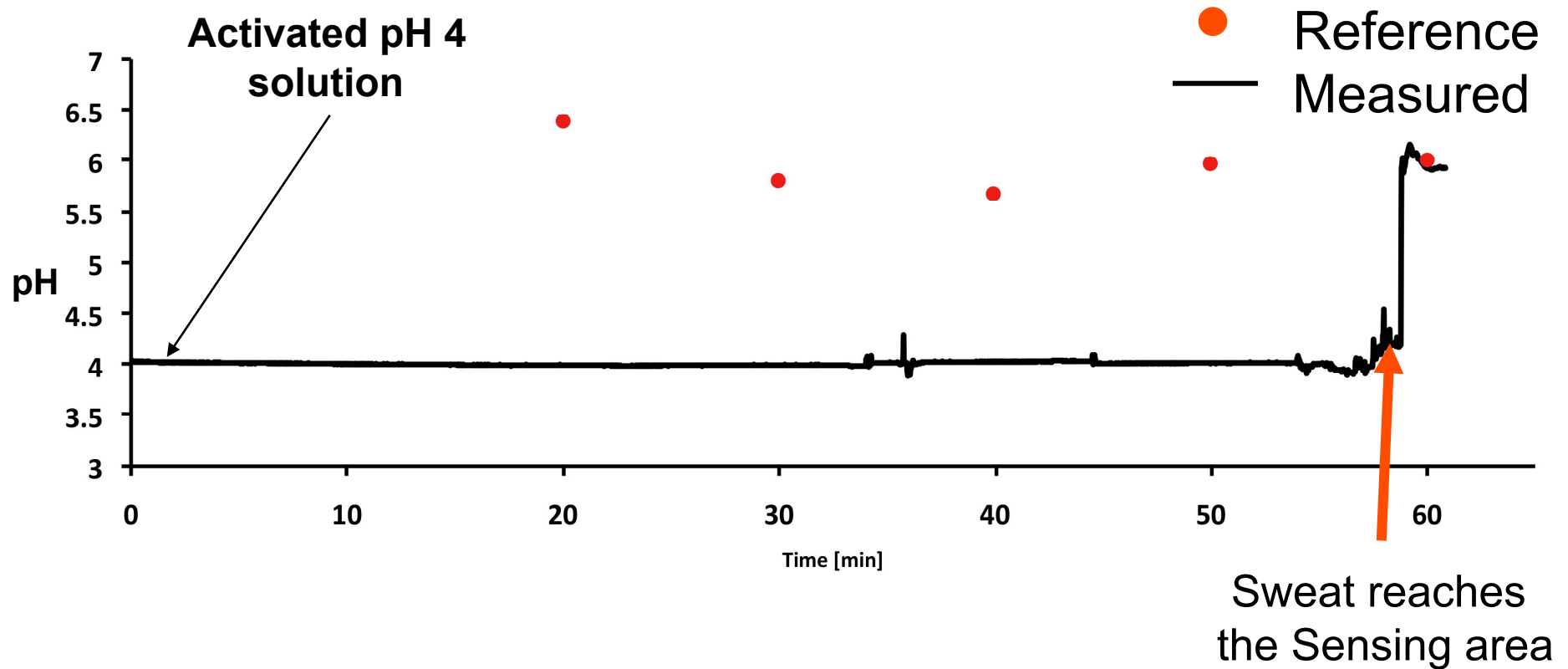


pKa determination of Bromocresol purple in the chip

PERFORMANCE

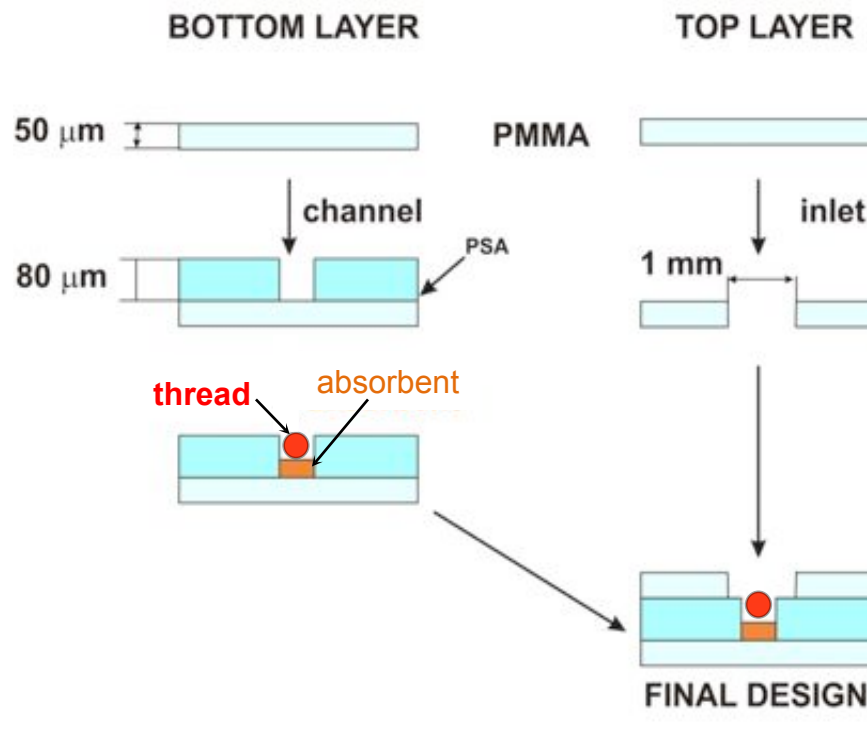
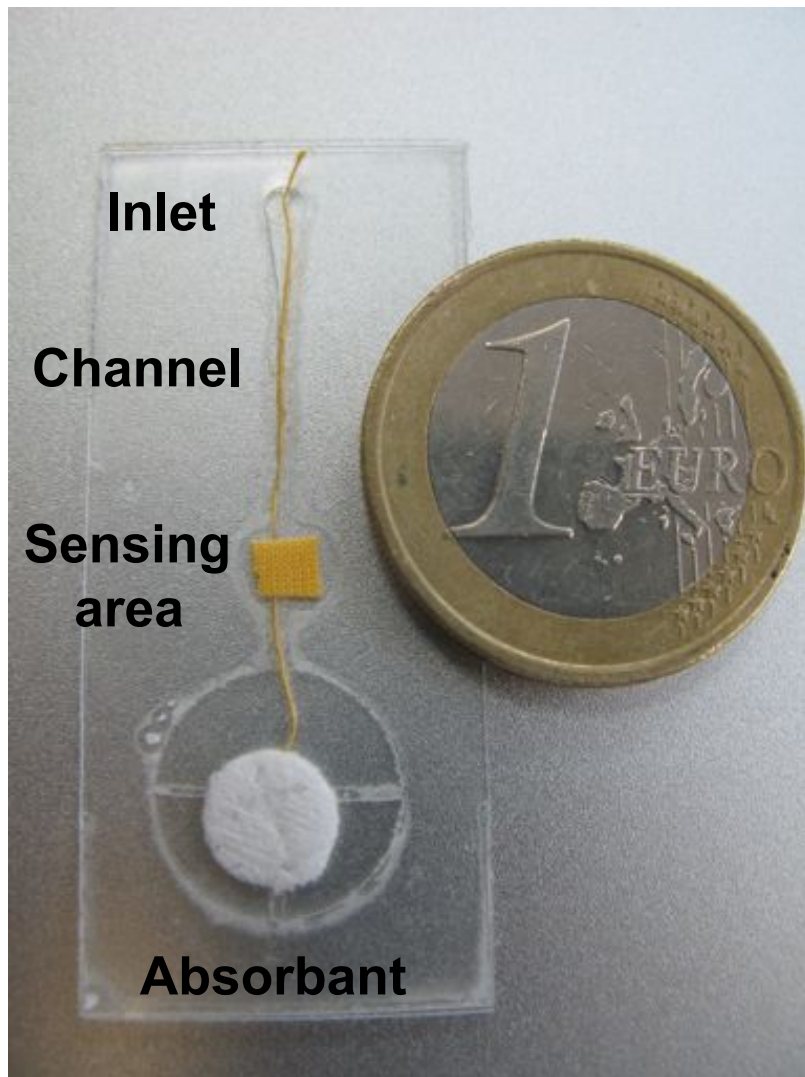


LED-PHOTODIODE STABILITY



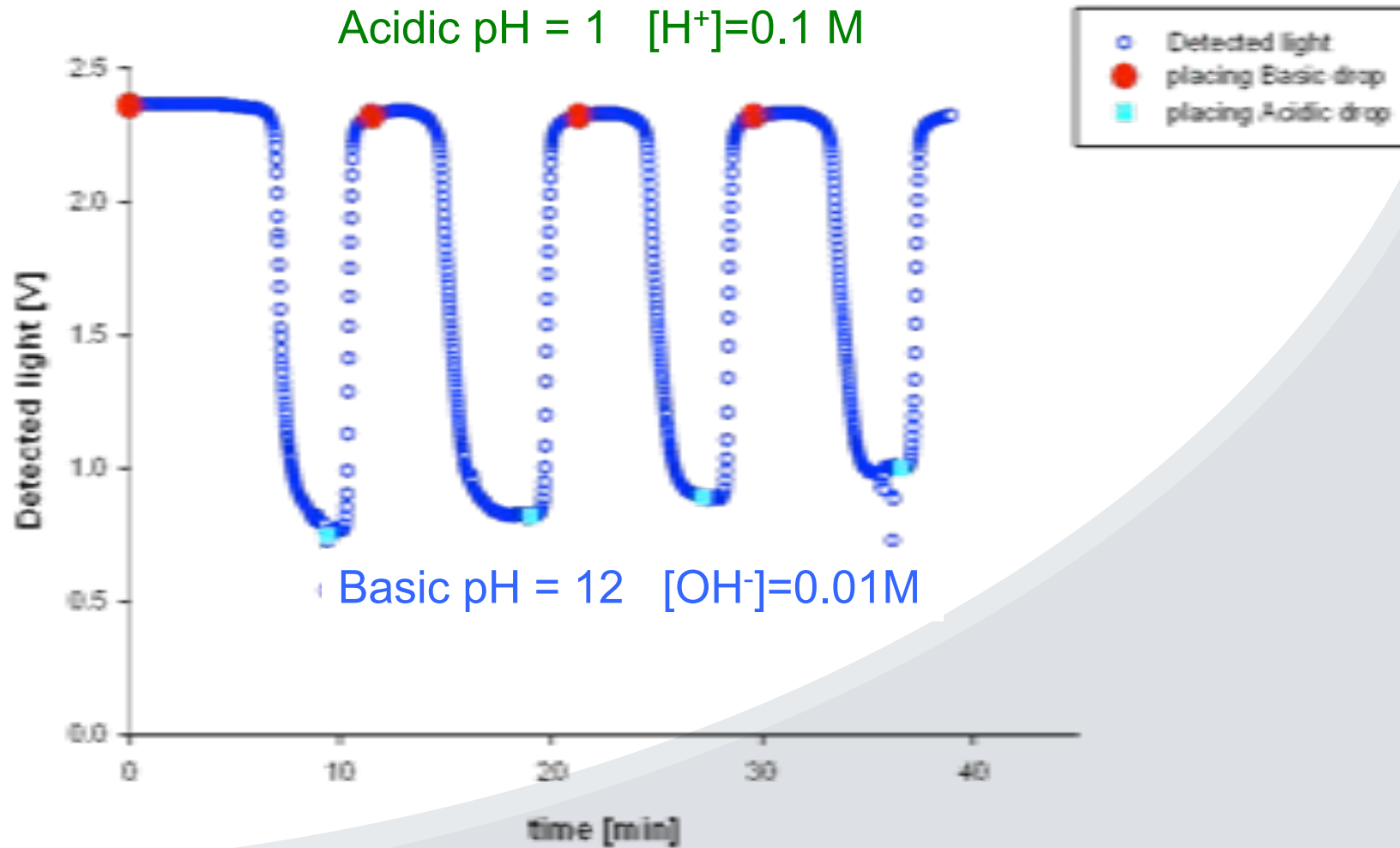
**Stability of the signal after 50 min. exercise.
LED alignment is not perturbed with athlete movement**

MICRO-DEVICE: Fabrication

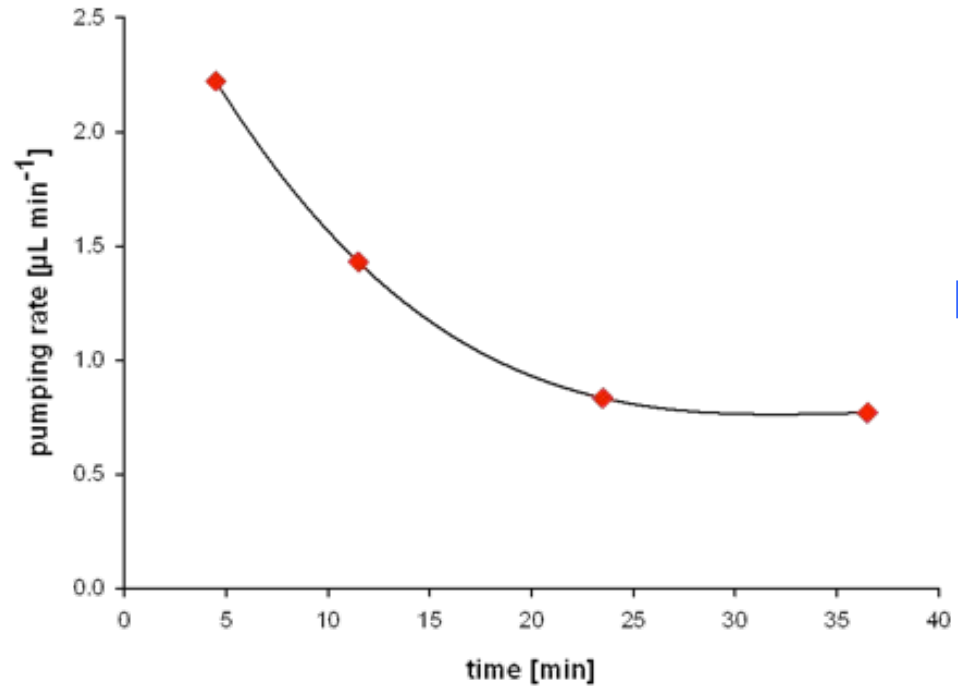


- pH dye bromocresol purple
- Flow = controlled by the thread
- Absorbant = passive pump

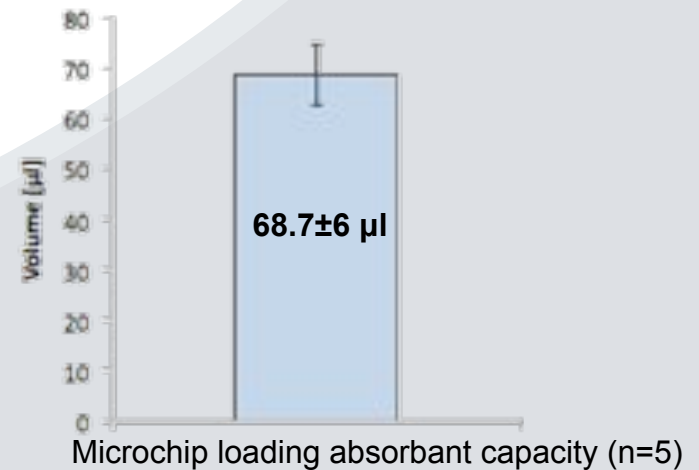
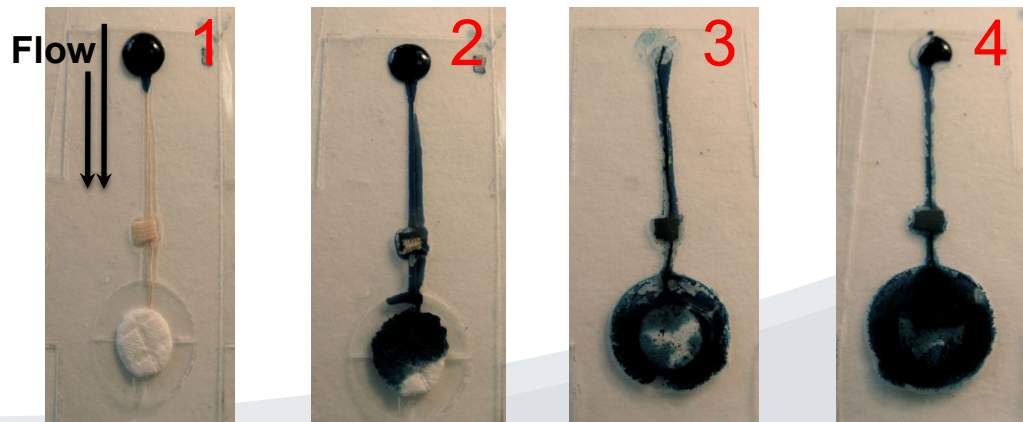
MICRO-DEVICE: Characterisation



MICRO-DEVICE: Characterisation

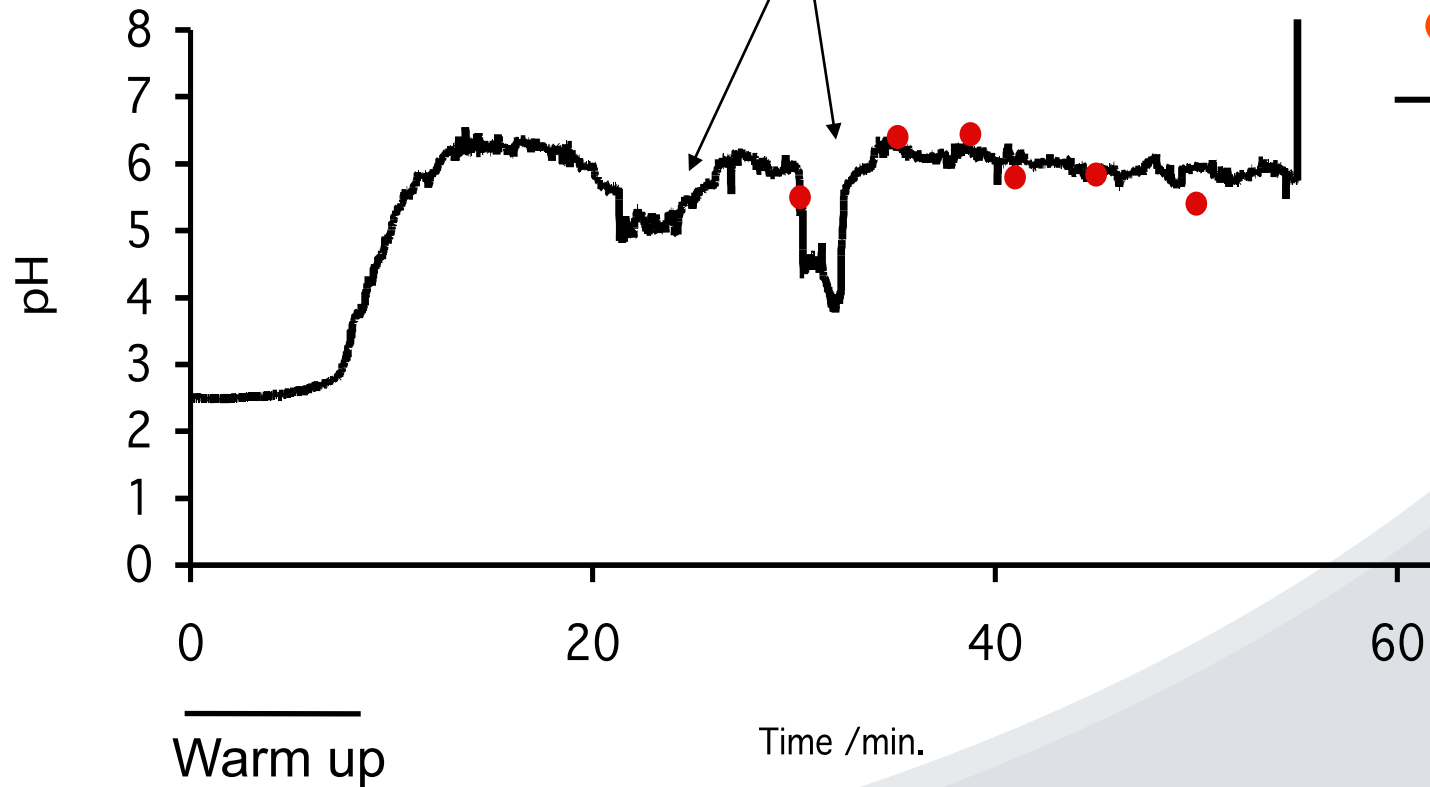


LIFE-TIME: ~ 63 MINUTES



ON BODY TRIAL

Resting time (easy cycling)



CONCLUSIONS

- The fabrication, characterisation and the performance of a wearable micro-fluidic system based on a textile fabric for monitoring in real time mode the pH of the sweat generated during an exercise period has been presented.
- Miniaturisation of the detector system
- Durability and accuracy of the device during athlete performance.
- Immediate feedback regarding sweat composition, pH, to individuals during sport activities.

FUTURE WORK:

- Run on body trials using the fully Autonomous Cordless platform by Tyndall.
- Establishment of a correlation between pH of the sweat and other physiological parameters, such as pH and lactate of blood and sweat electrolytes.

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QUESTIONS?