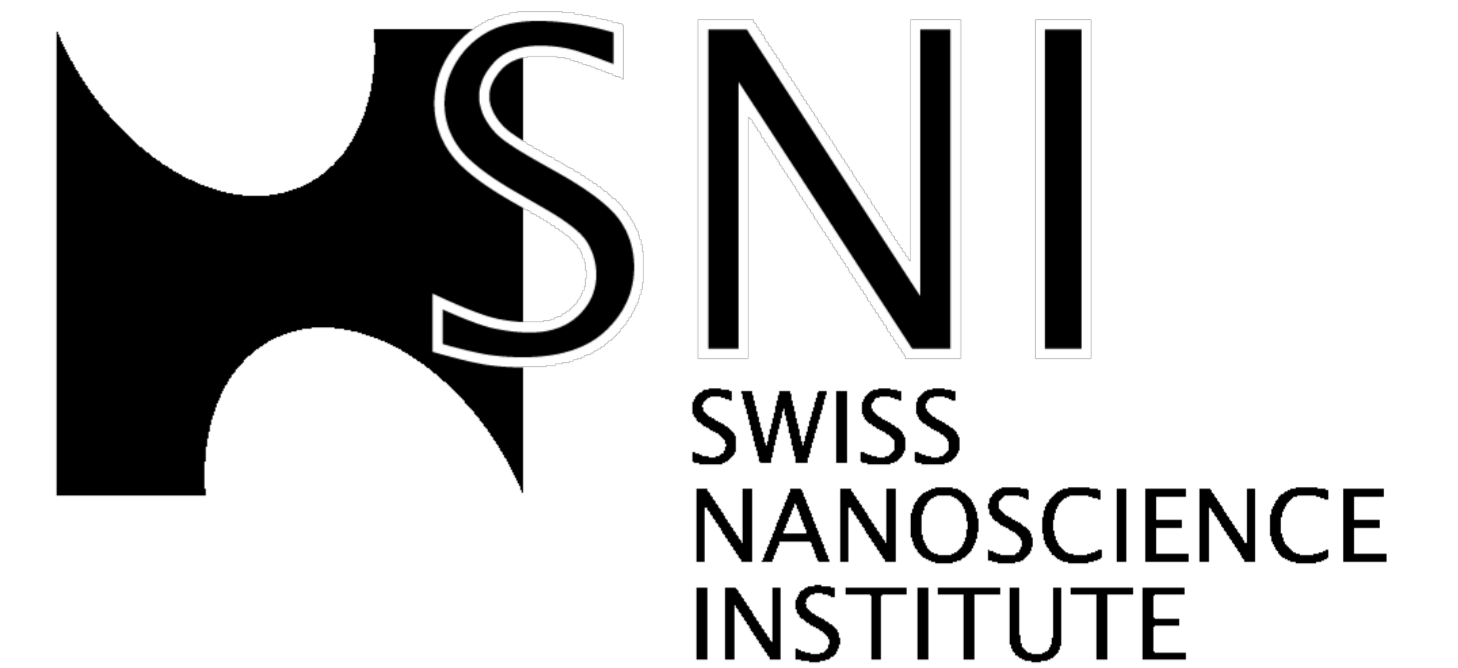


Nanomechanical membrane surface stress sensors for medical breath testing

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EINE INITIATIVE DER UNIVERSITÄT BASEL UND DES KANTONS AARGAU

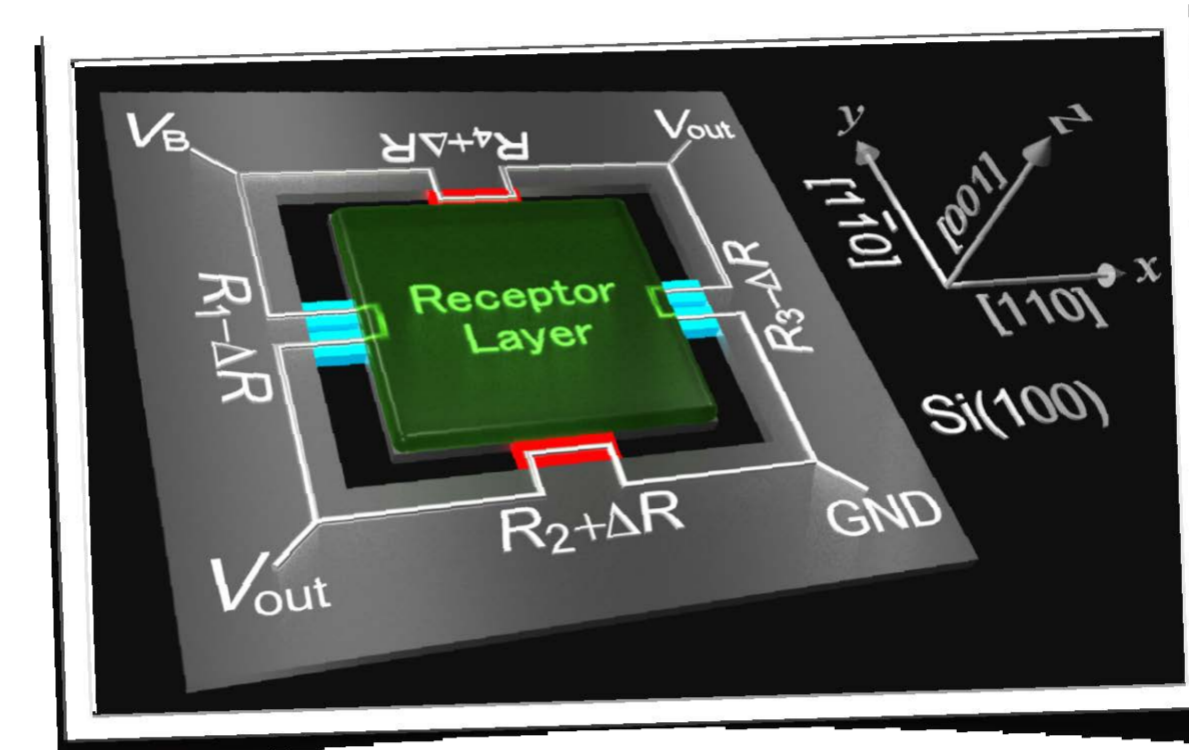
1. Motivation and Introduction

- Probe Array Technology in Life Sciences (PATLiSci) is used to detect head & neck and lung cancer in a non-invasive way using breath samples of patients prior and after medical treatment in hospital
- Breath samples will be collected at Centre hospitalier universitaire vaudois (CHUV) and stored in 1 liter Tedlar bags at 4° C prior to investigation
- Responses from eight membrane surface stress sensors (MSS) represent the dataset for characterization of the breath sample
- Series of consecutive exposure and purging steps for repeatability, reproducibility and robustness.
- Data evaluation via principal component analysis (PCA)
- Electronic nose technique characterizes breath samples, but does not yield a full chemical analysis like HPLC etc.
- Similar breath samples form a distinct cluster of data points in PCA. Differing samples (i.e. from sick and healthy persons) produce data points at different locations in the PCA plot.
- PCA ,reduces' the amount of data by projection of a multidimensional data set onto a two dimensional plane, whereby in a least-square method largest differences between dissimilar datasets are extracted.

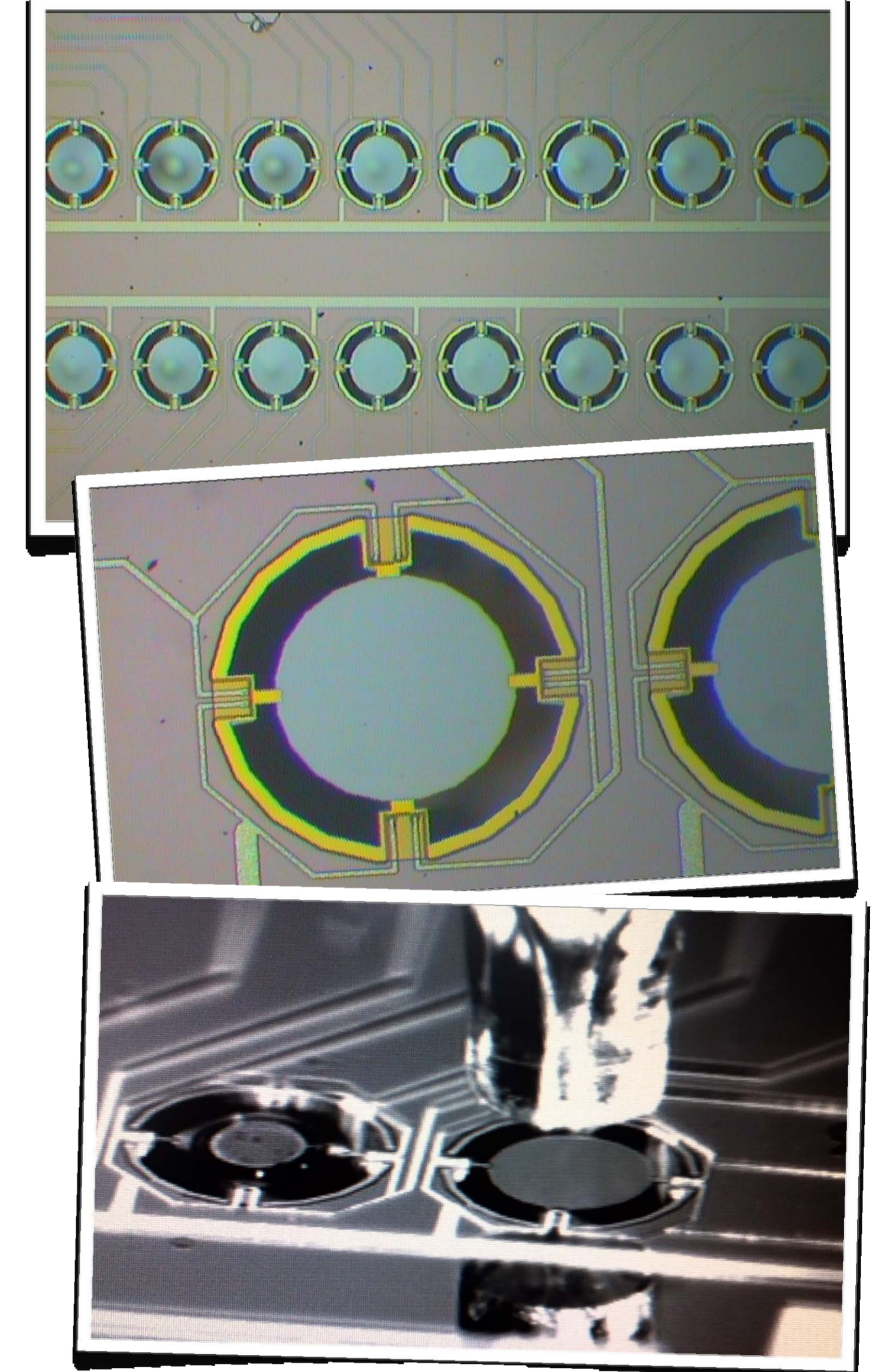


1 Liter Tedlar bag for collection of patients' breath samples

2. Membrane Surface Stress Sensors (MSS)

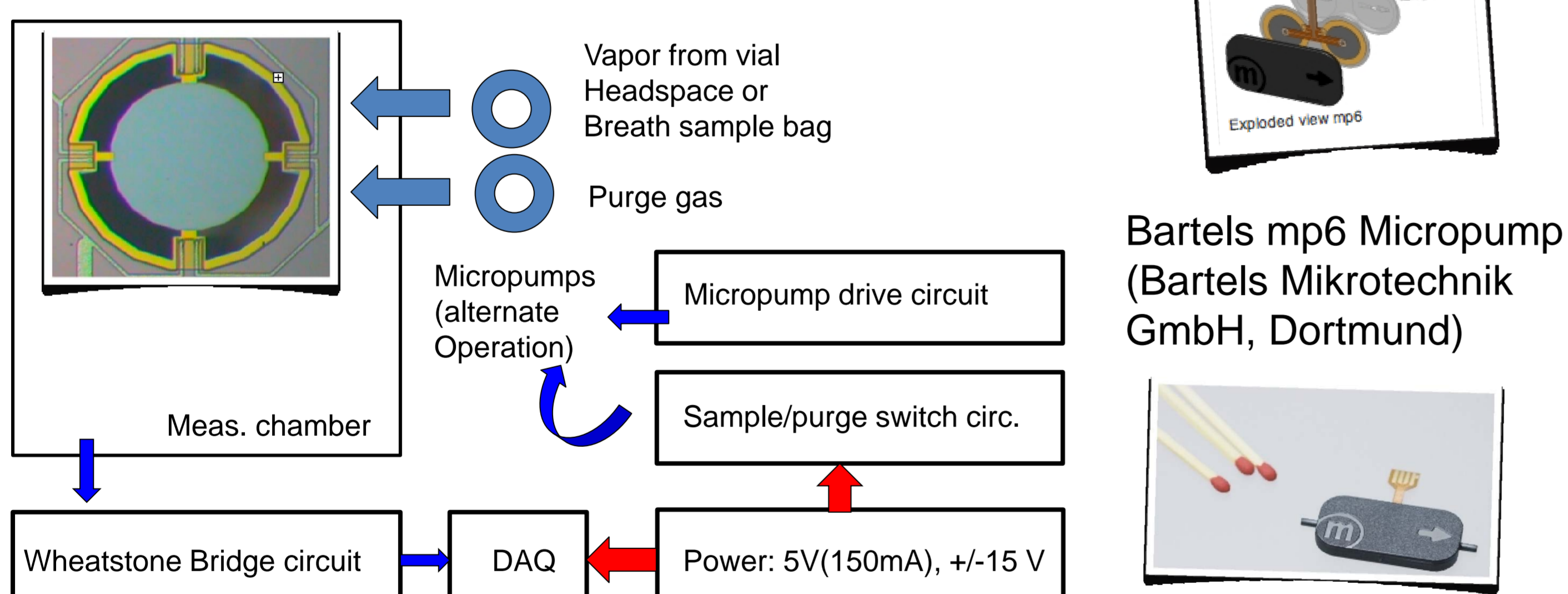


- Microfabricated piezoresistive Membrane Surface Stress Sensors
- Full Wheatstone bridge geometry
- Four times more sensitive than cantilever beams
- Membrane diameter: 500 micron
- Functionalisation by coating with polymers using inkjet spotting
- On exposure to volatile organic compounds (VOCs), the polymer layer swells, producing surface stress and bulging of the membrane
- Presence of VOCs detected in piezo-resistive response.



Microfabrication: EPFL / CSEM

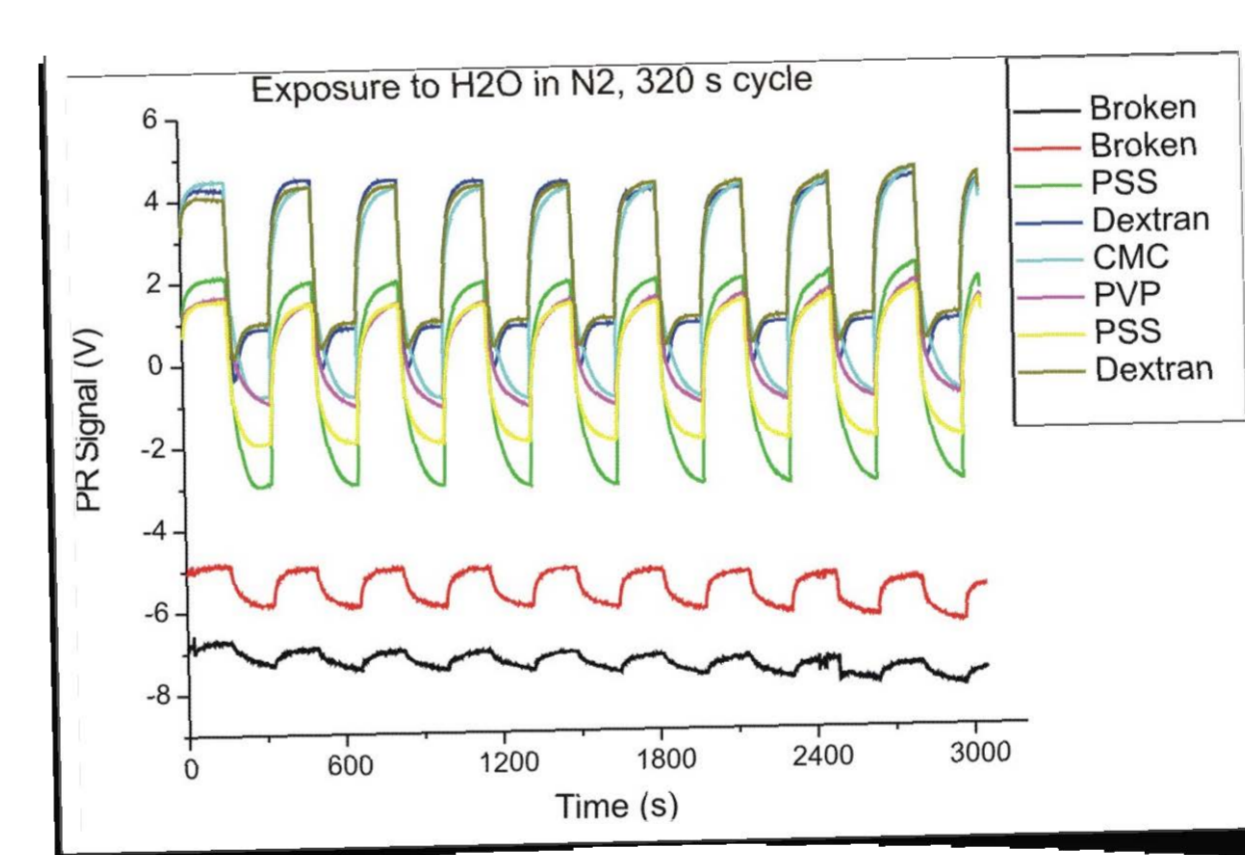
3. Experimental Setup



Electronics for parallel measurement of eight piezoresistive MSS (A. Tonin, Univ. Basel)

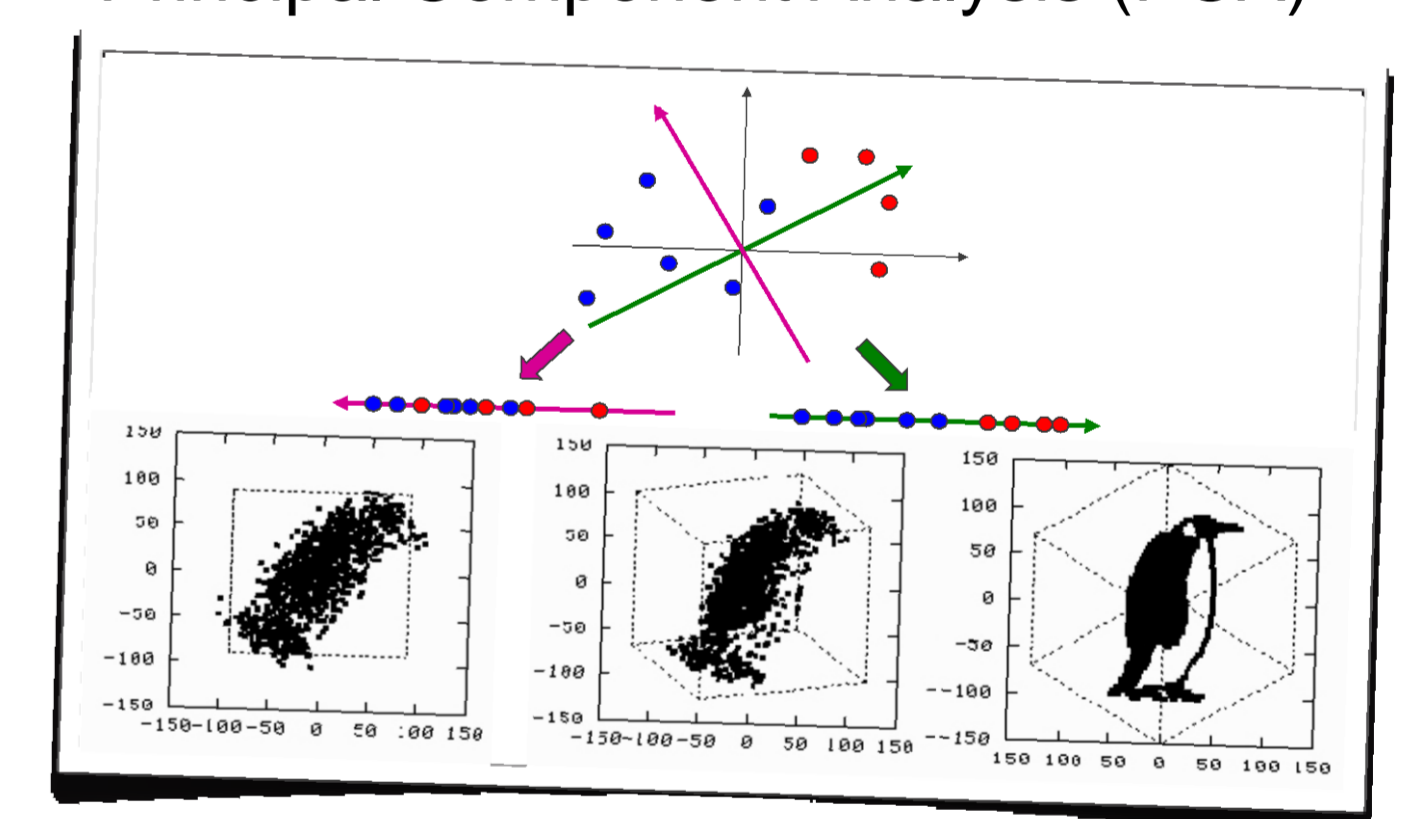
Mobile and portable setup uses netbook computer. Sensor electronics power supply and data acquisition via USB port of the computer.

4. Results

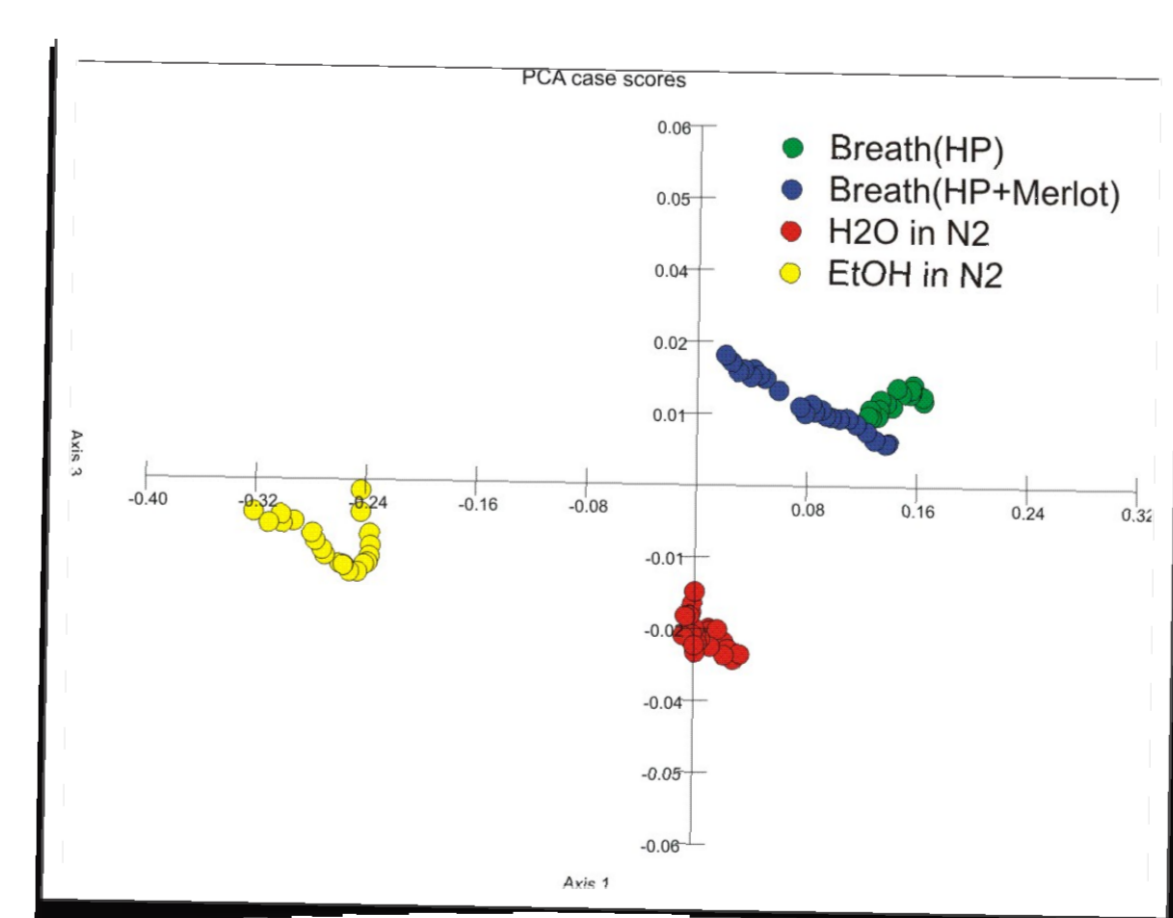


MSS test using saturated vapor in a Tedlar bag filled with N₂

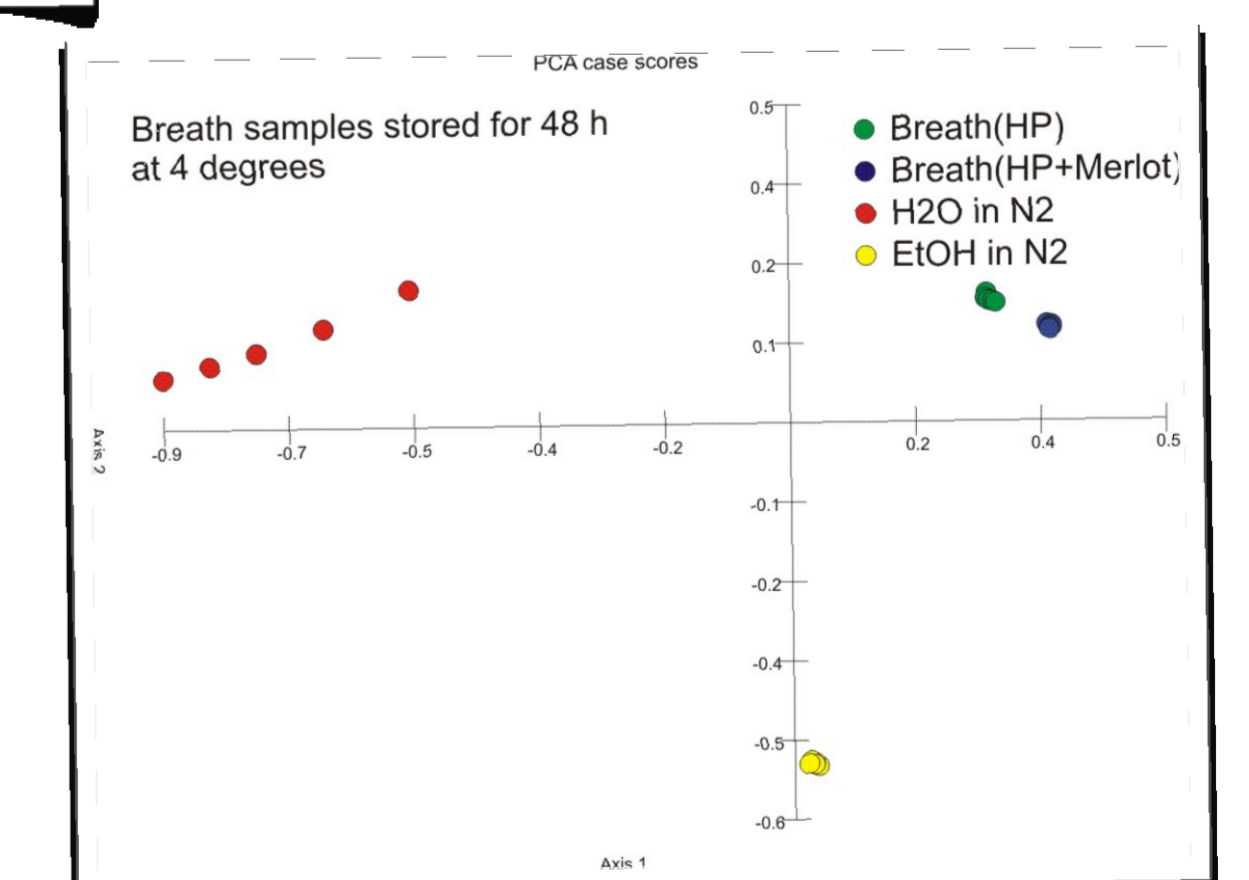
Principal Component Analysis (PCA)



Test substance for before / after breath test



PCA of breath samples and VOCs directly after sample collection



With different measurement cycle duration after storage for 48 h at 4 deg C

5. Further Work – Clinical Study

- The clinical study has been approved by the ethics committee in April 2012
- First patients' breath samples will be collected end of April 2012 and during May - June
- Double blind study with 10 head & neck cancer patients before and after treatment at CHUV, 10 healthy subjects
- Clinical study with more patients planned for second half of 2012

6. References - Literature

- A cantilever-array based artificial nose, M.K. Baller et al, Ultramicroscopy **82**, 1-9 (2000)
- Diagnosing disease by nanomechanical olfactory sensors: D. Schmid et al, Eur. J. Nanomedicine **1**, 44-47 (2008)
- Towards a modular, versatile and portable sensor system for measurements in gaseous environments based on microcantilevers, H.P. Lang et al, Procedia Chemistry **1**, 208-211 (2009)