Capteurs de force nano-mécaniques pour la détection du cancer

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Neuchâtel, le 12 mars 2014

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Probe array technologies

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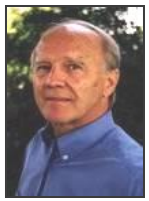
Optics


N. de Rooij, P. Vettiger, J. Brugger
EPFL-IMT, *MEMS design & fab*

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Membrane prot. immobilisation

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Melanoma

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EPFL-IMT
Fluidics

A. Mariotti
CePO, CHUV
Melonoma progression

Cancer

- Cancer – leading cause of death (~30% of deaths)
- Late detection is a major contributor to high death rates
- Existing detection methods often invasive (biopsies) or expensive (MRI)
- Need low-cost, non-invasive screening method for cancer

Dogs Smell Cancer in Patients' Breath, Study Shows

Stefan Lovgren
for National Geographic News
January 12, 2006

Dogs can detect if someone has cancer just by sniffing the person's breath, a new study shows.

Ordinary household dogs with only a few weeks of basic "puppy training" learned to accurately distinguish between breath samples of lung- and breast-cancer patients and healthy subjects.

Enlarge Photo

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"Our study provides compelling evidence that cancers hidden beneath the skin can be detected simply by [dogs] examining the odors of a person's breath," said Michael McCulloch, who led the research.

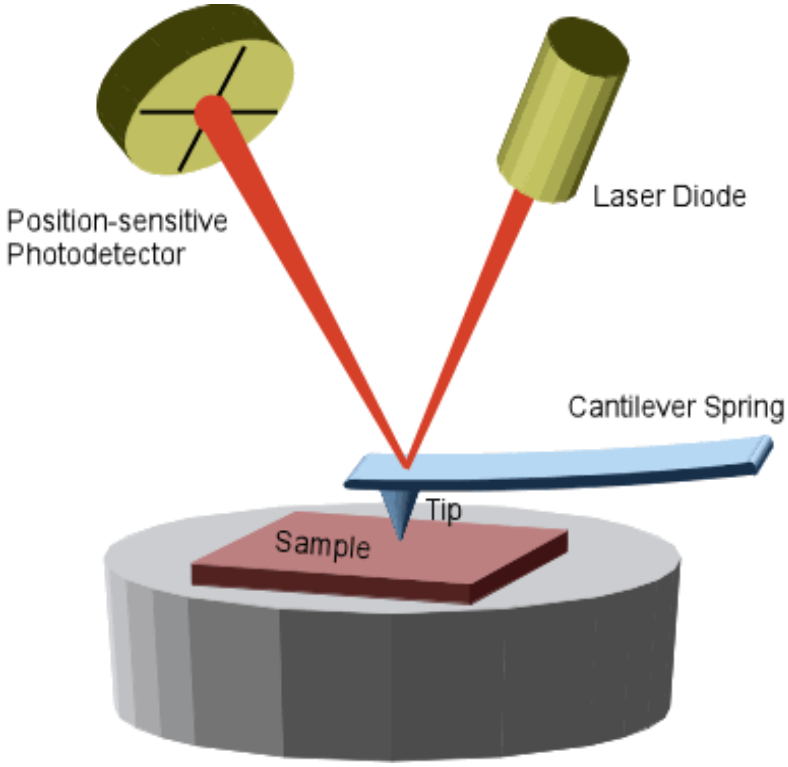
Early detection of cancers greatly improves a patient's survival chances, and researchers hope that man's best friend, the dog, can become an important tool in early screening.

The new study, slated to appear in the March issue of the journal *Integrative Cancer Therapies,* was conducted by the Pine Street Foundation, a cancer research organization in San Anselmo, California.

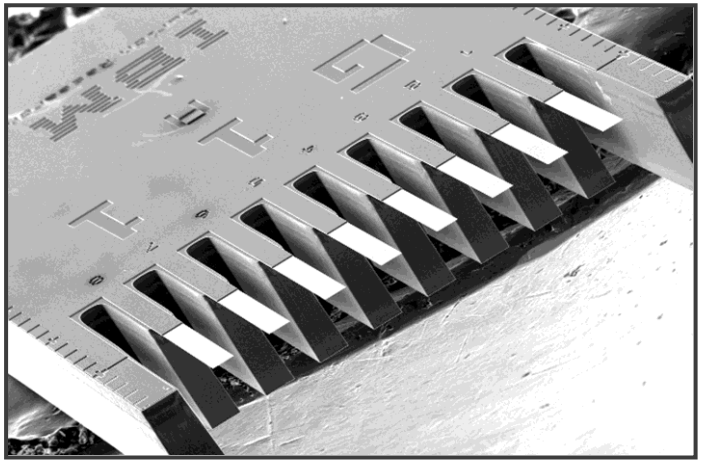
Atomic Force Microscopy

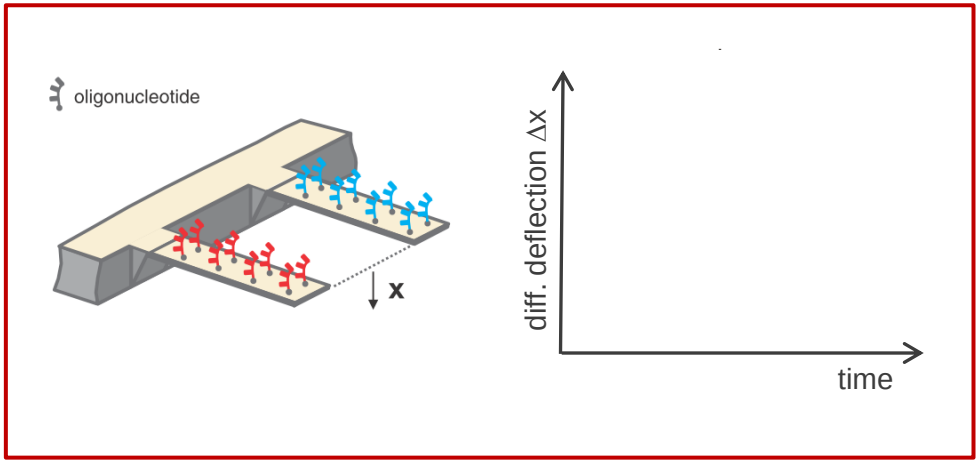
- Flexible cantilever acts as a spring to measure forces between tip and sample
- Local attractive or repulsive forces are converted into a deflection of the cantilever
- Cantilever deflection is converted into an electrical signal by a quadrant photodiode

- Extreme resolution in force (pN) and in distance (sub nm)



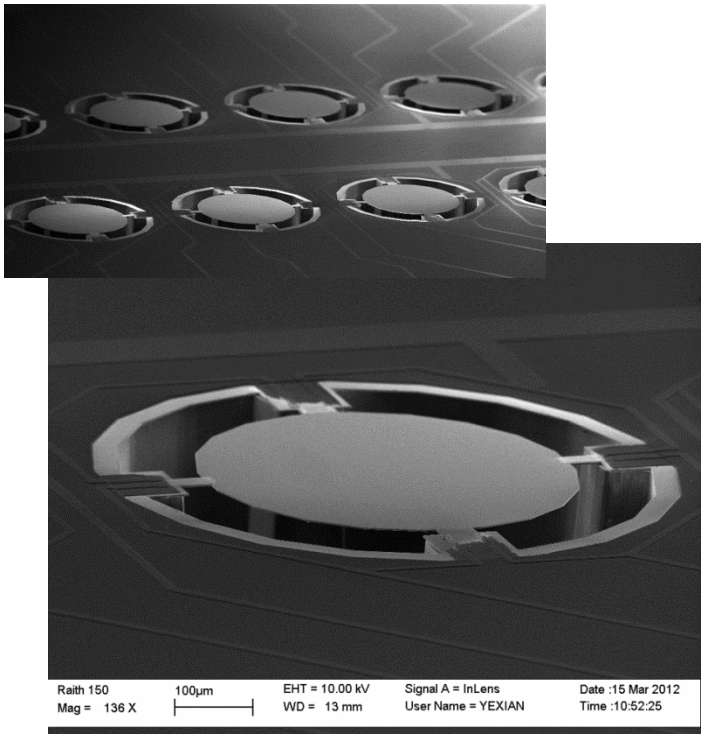
Nanomechanical biosensing

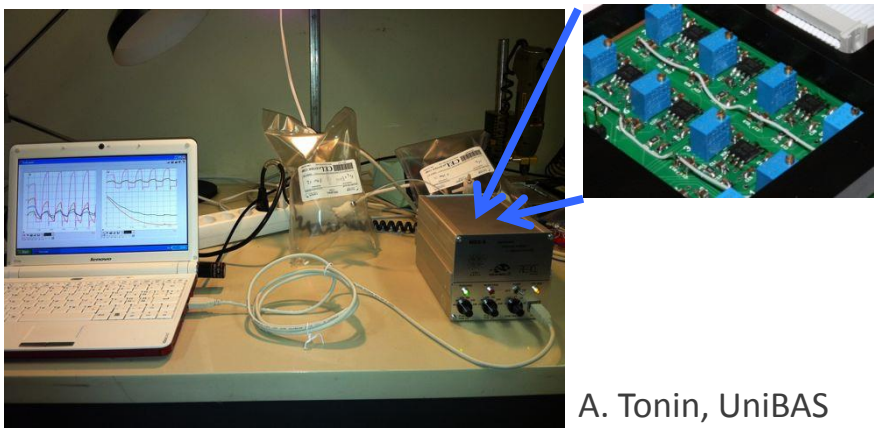




- each cantilever is functionalized for molecular recognition (ex: oligonucleotides)
- Probe cantilevers coated with a specific layer for target capture
- Reference cantilevers coated with a non-specific layer
- Differential measurement reveals net signal and cancels thermal drift

Membrane Surface Stress Sensors & Electronics



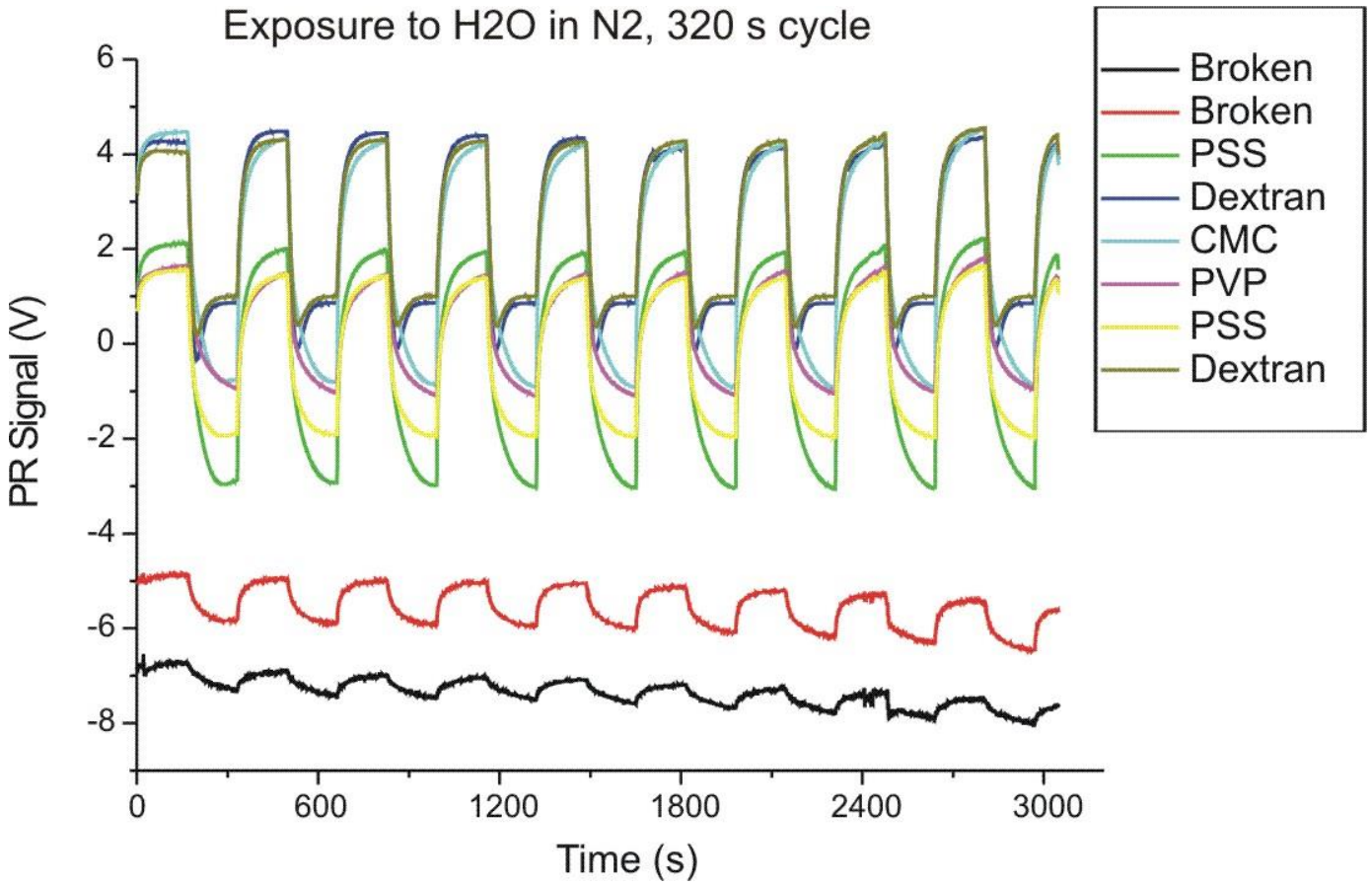


A. Tonin, UniBAS

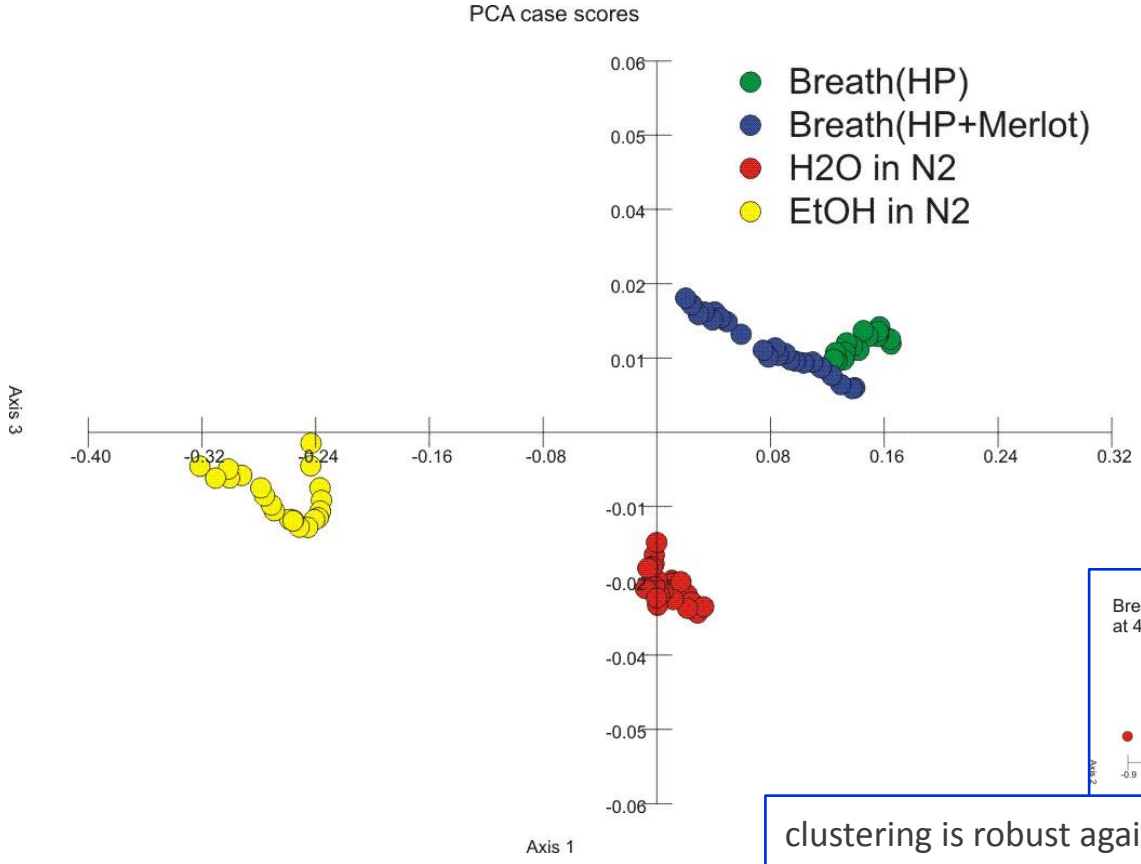
Inkjet spotting for MSS coating
e.g. polymers such as PSS, Dextran, CMC, PVP

📖 F. Loizeau, EPFL-IMT (2012)

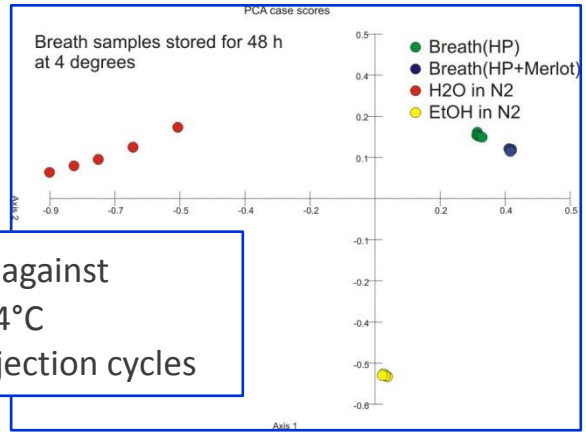
Membrane sensor response to solvent vapor



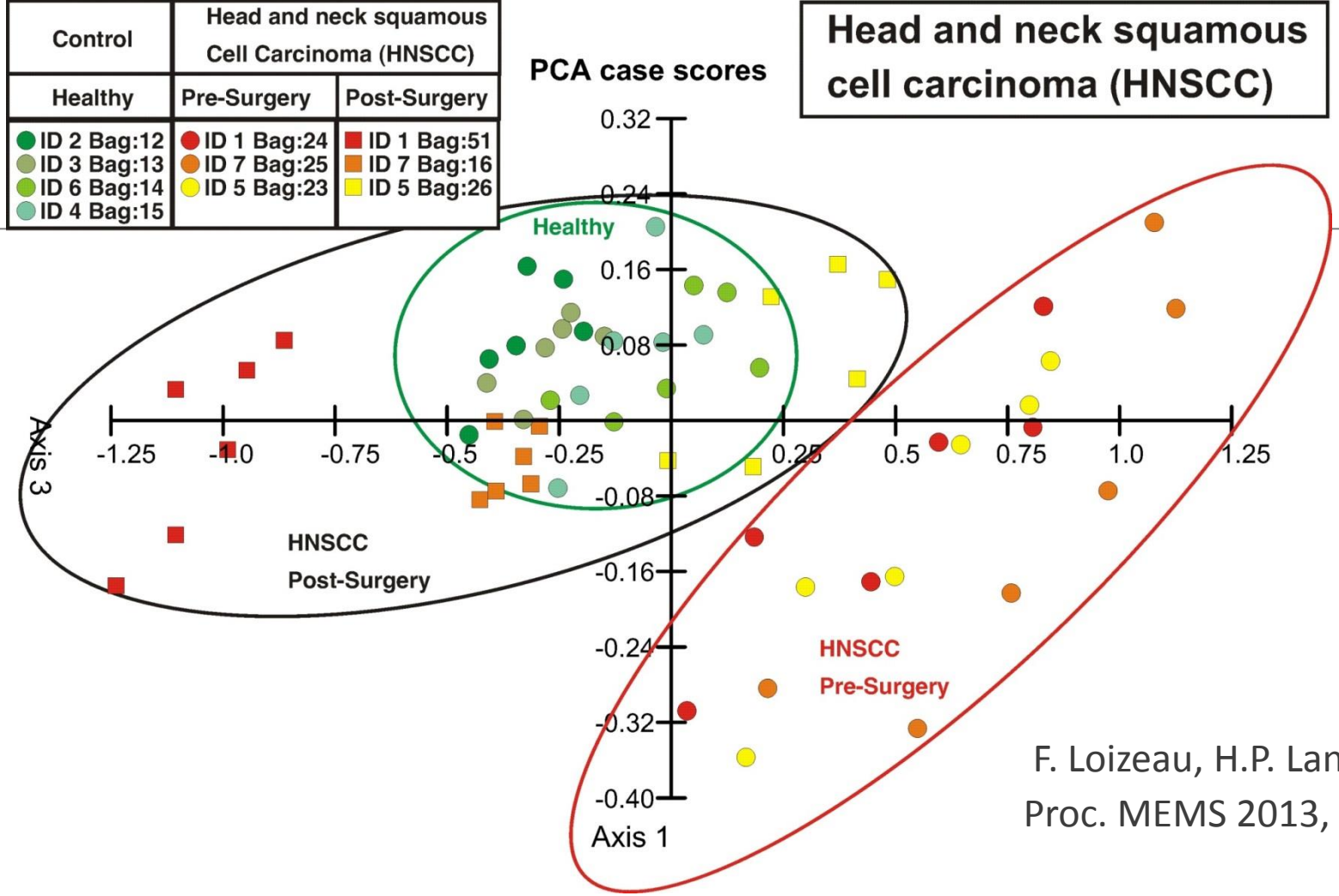
Selectivity to breath and VOC samples



test substance



clustering is robust against
storage for 48 h at 4°C
and variations in injection cycles



F. Loizeau, H.P. Lang et al.
Proc. MEMS 2013, p. 621

- Breath samples collected on head & neck cancer patients before and after surgery
- Control: breath samples from healthy smokers
- Clinical study continuing

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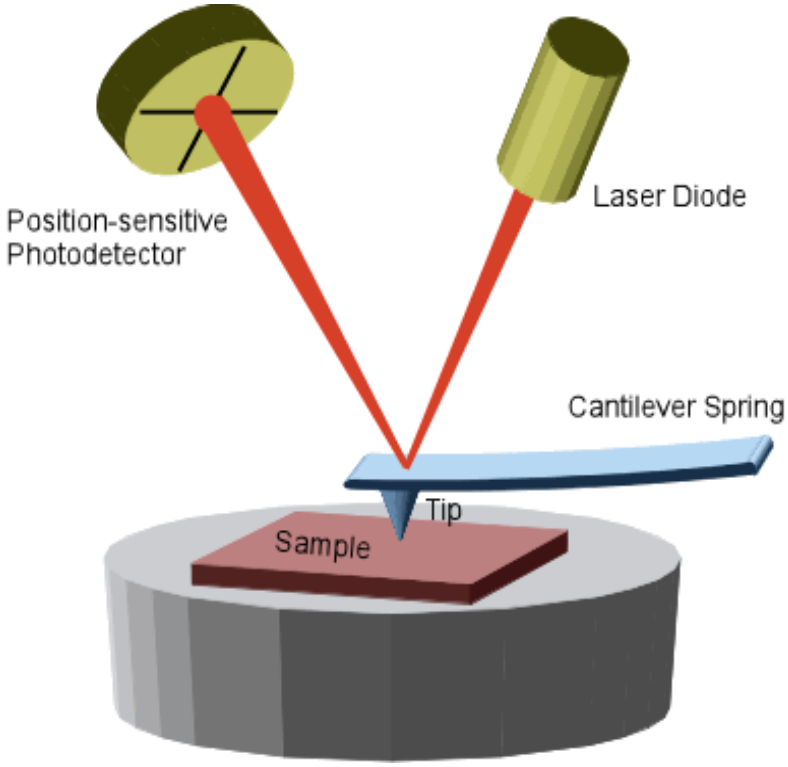
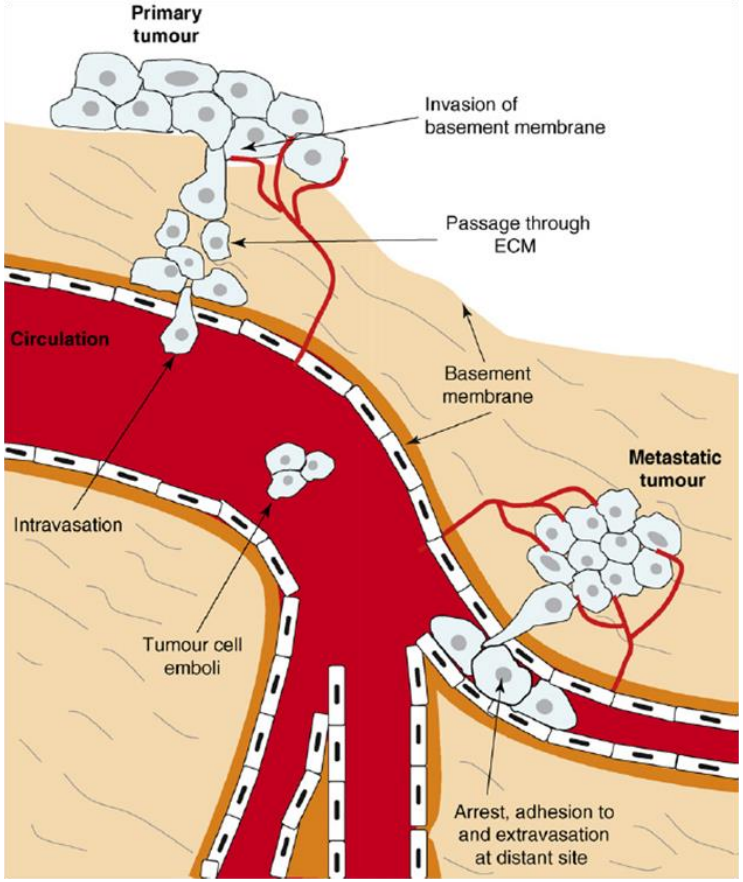
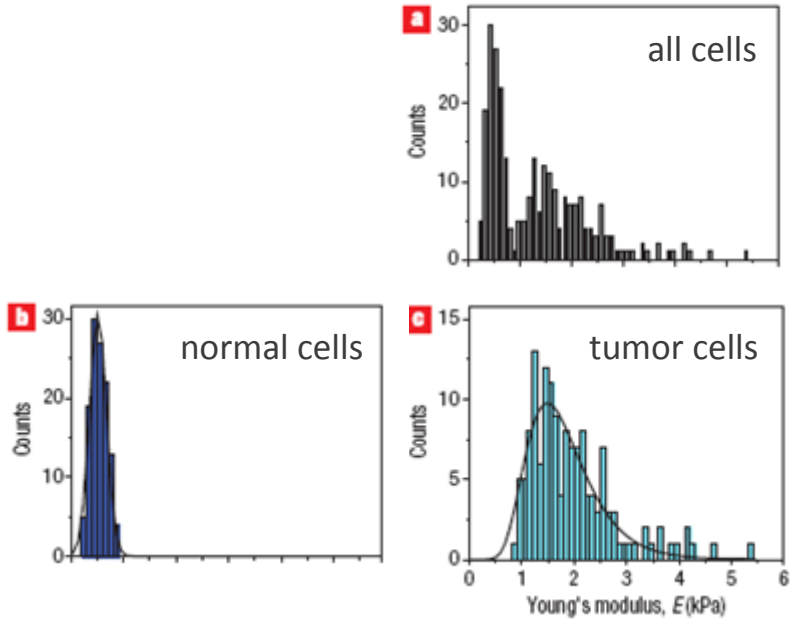


Motivation: metastatic cancer development

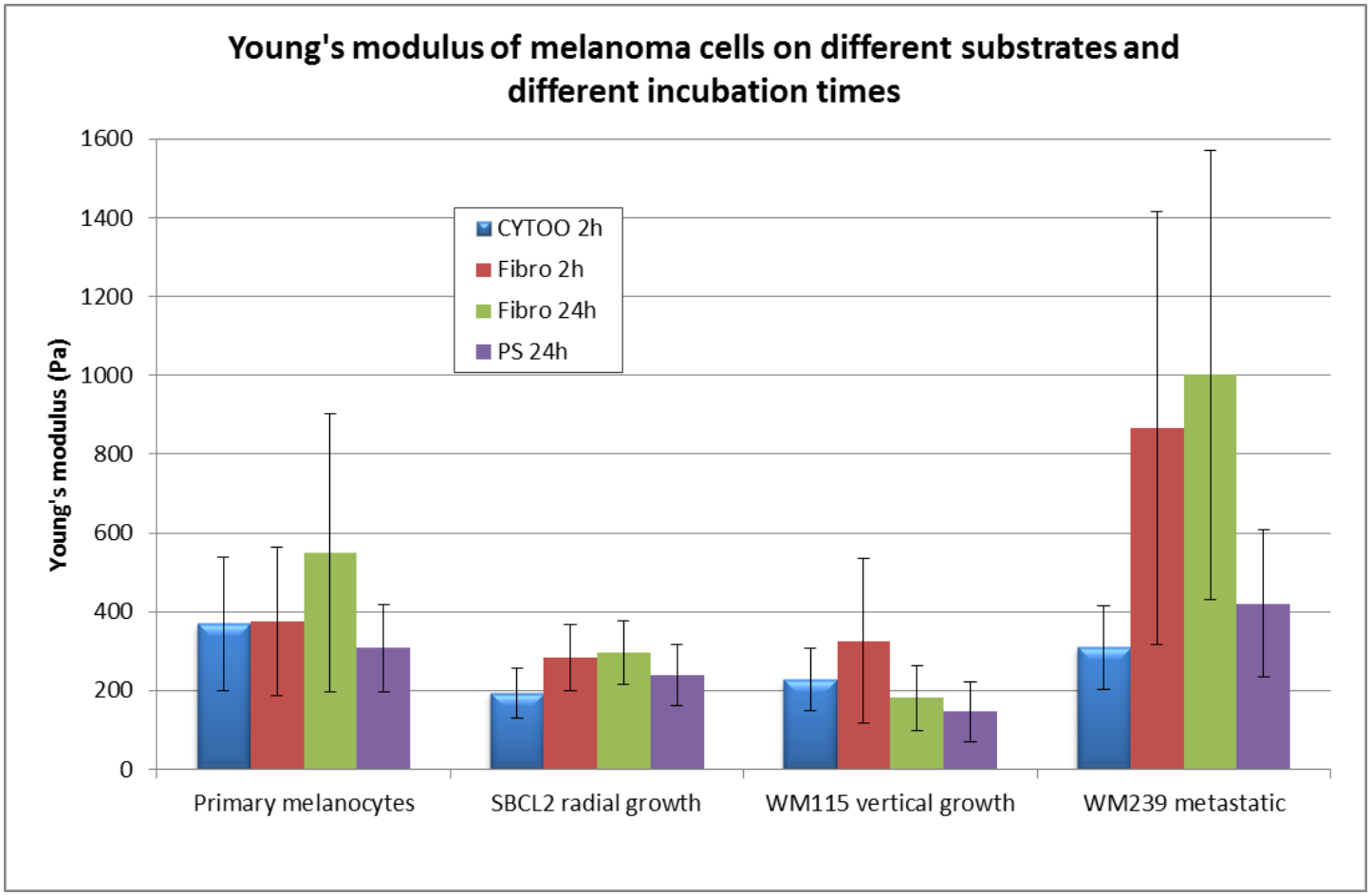




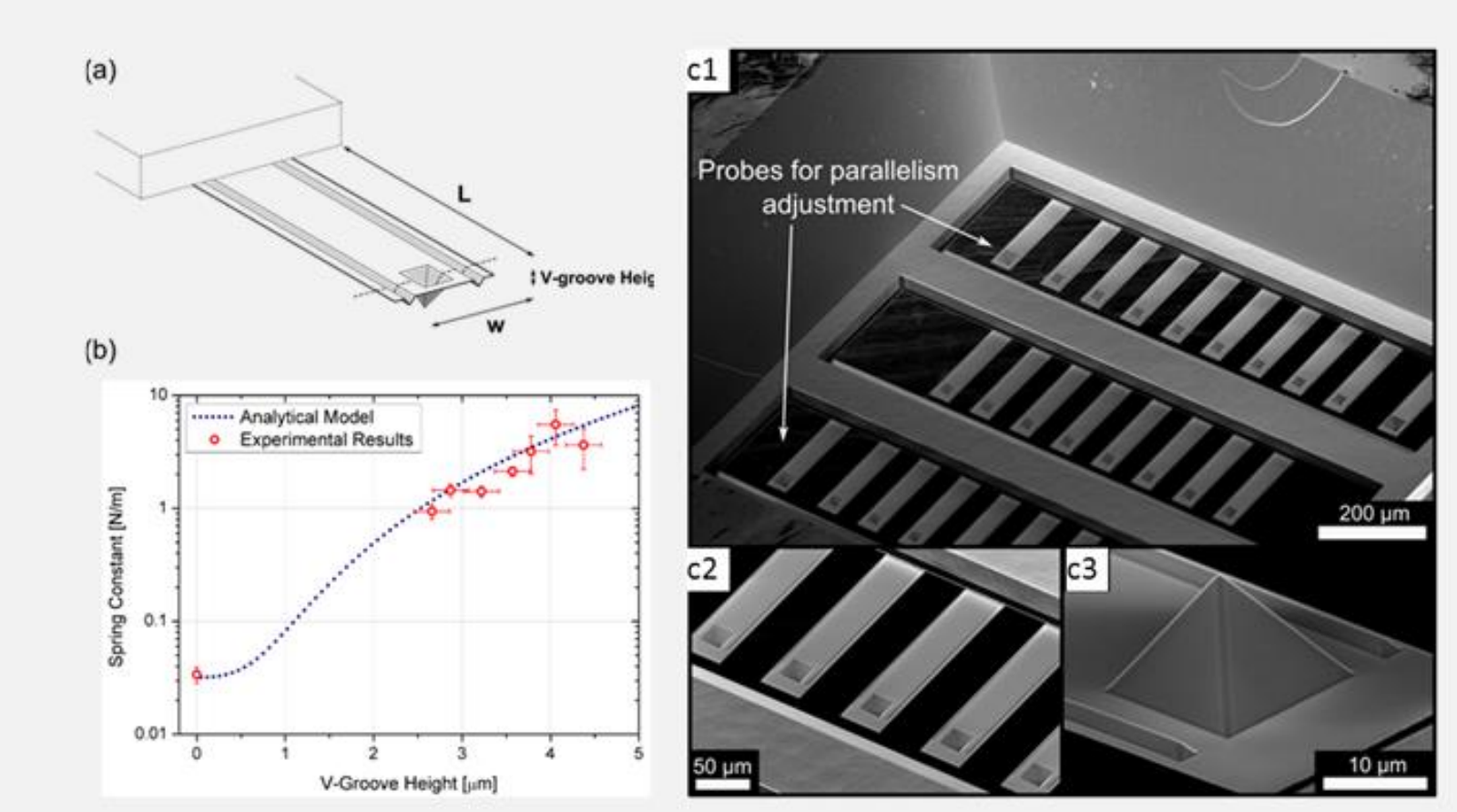
Lee *et al.*, Trends Biotechnol. 2007

S.E. Cross *et al.*, Nature Nanotech (2007)

Elasticity of Melanoma cells

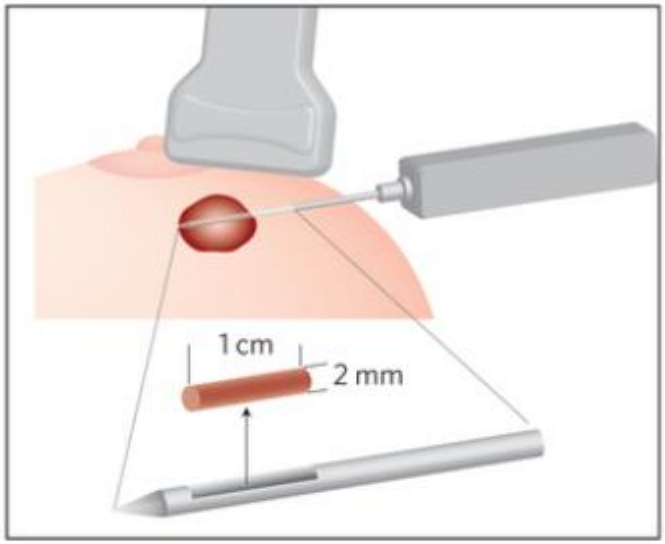


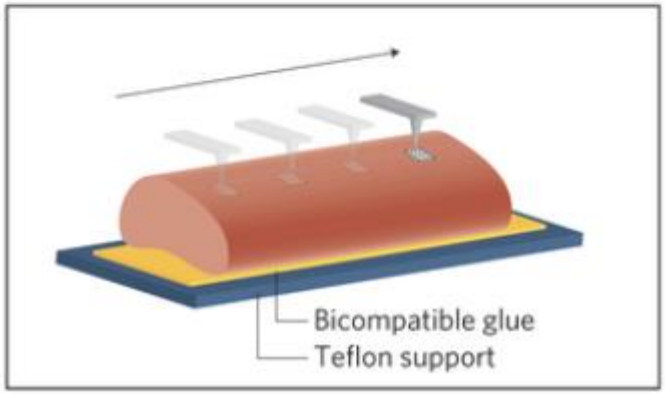
Probe Arrays for parallel force spectroscopy

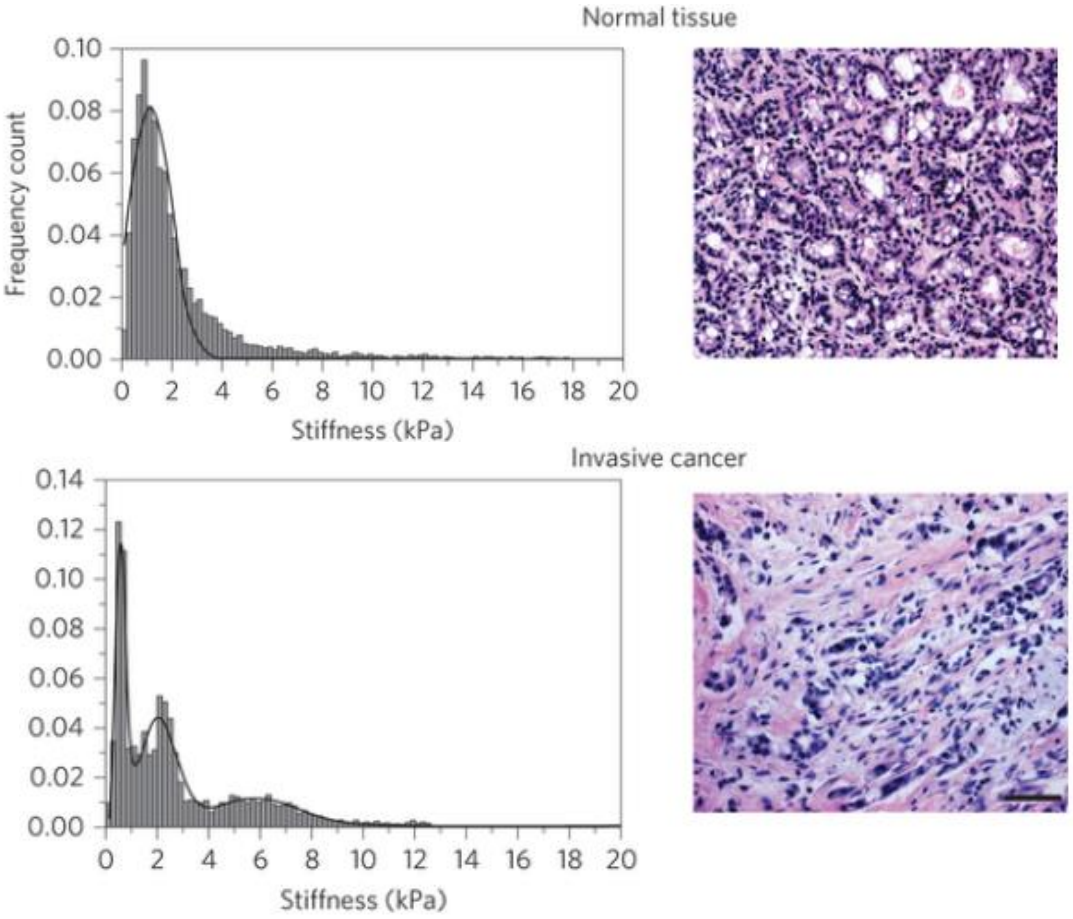


F. Loizeau *et al.,* MicroNanoLetter 2012 (in press)

Nanomechanical measurement of breast cancer



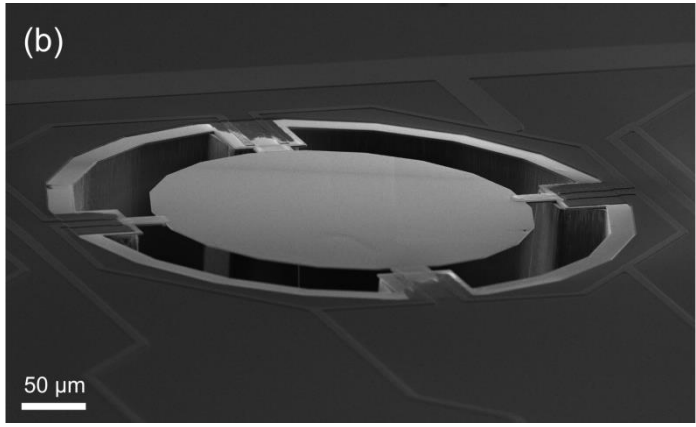




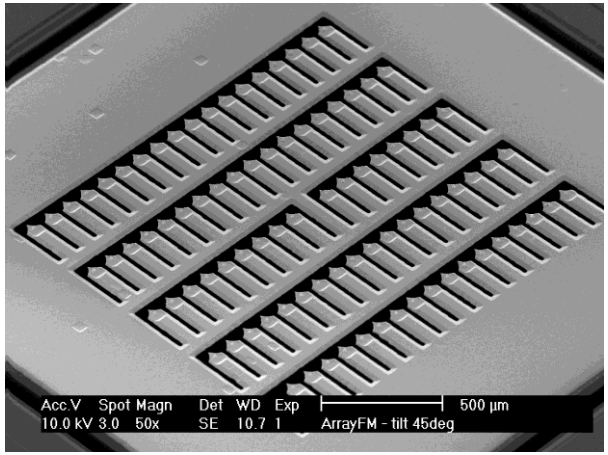
M. Plodinec *et al.,* Nature Nanotechnology, **7**, 757(2012)

Conclusions:

- Nanomechanical sensors can be used to detect volatile organic compounds in breath
- This allows rapid, non-invasive detection of some types of cancer
- The instrumentation is compact, and easy to use



- Nanomechanical sensors can also be used to detect cancerous cells in culture or in biopsies
- Faster detection is necessary to bring this method to the operating theatre



Thank you for your attention.