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FNSNF

Parallel Atomic Force Microscopy for Rapid Nanomechanical Tissue Diagnostics

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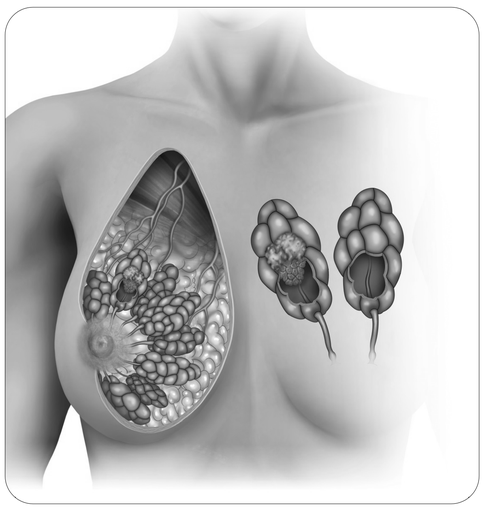
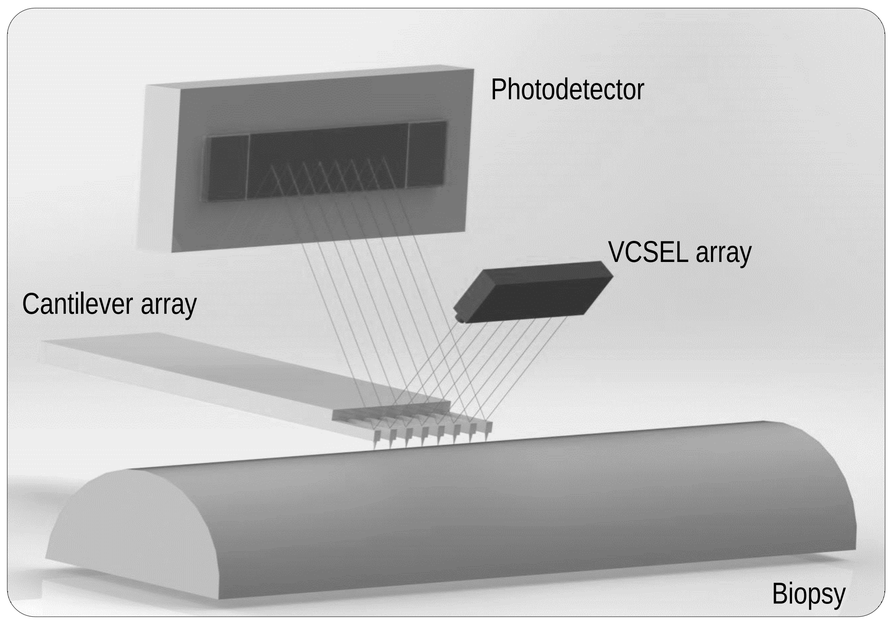
The development of cancer is associated with mechanical changes in both cells and extracellular matrix in living breast tissue. The histological analysis of breast cancer biopsies is currently a qualitative process requiring a visual diagnostic expertise. Alternatively, recent work has demonstrated a quantitative approach to biopsy analysis: the use of Atomic Force Microscopy (AFM) to measure the local nanomechanical properties of the biopsy. Comparative tests of AFM and histological analysis of breast cancer biopsies have demonstrated a reliable correspondence of the two approaches. An AFM analysis requires the acquisition of around 10'000 individual force displacement curves for a statistically meaningful set of data which takes several hours. It is, however, too slow for clinical use. CSEM is developing a new rapid diagnostic tool using parallelized AFM cantilevers to investigate breast biopsy samples rapidly. The innovation is to reduce the AFM analysis time from hours to minutes.

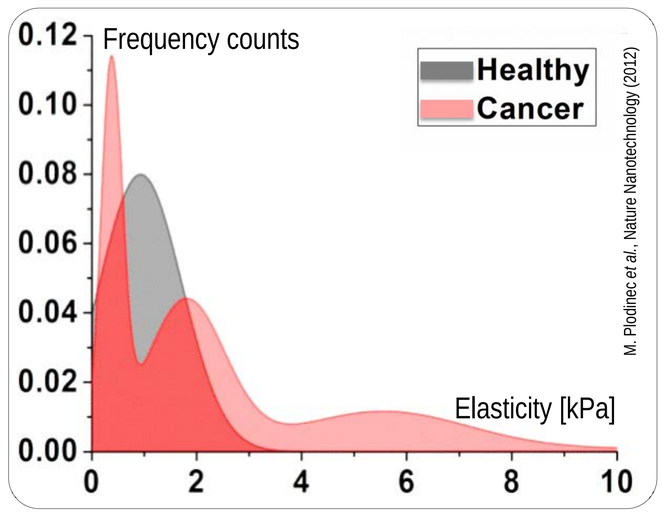
CONCEPT



I. BREAST BIOPSY SAMPLES



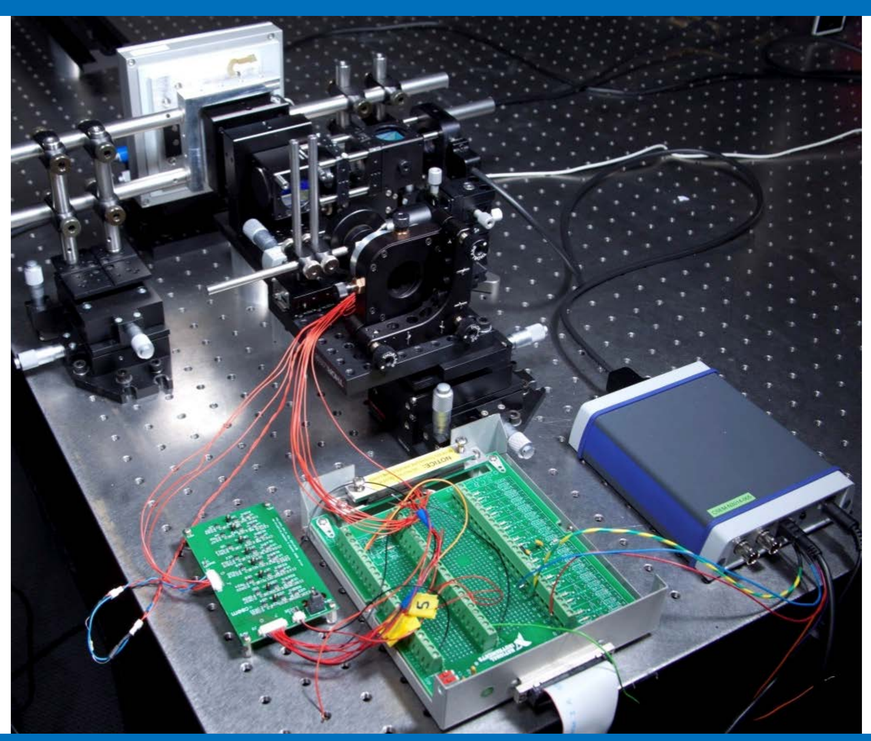
II. PARALLEL AFM NANOINDENTATION

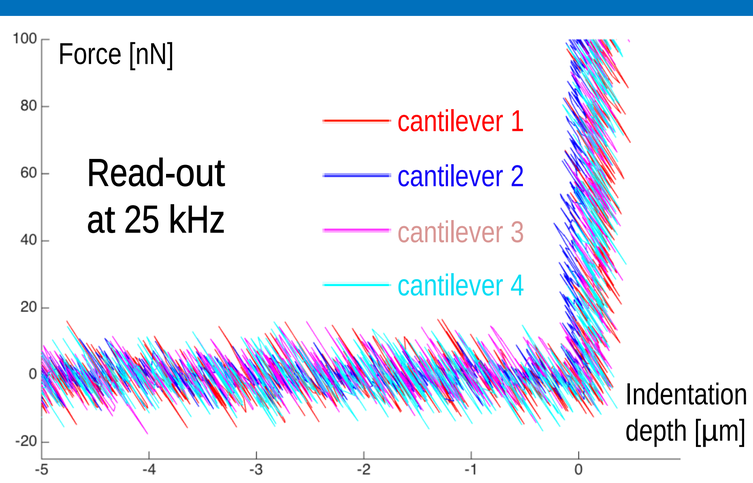


III. TYPICAL HEALTHY AND CANCER ELASTICITY PROFILES

DEMONSTRATION

The standard procedure uses a single AFM cantilever to measure the nanomechanical profile of the biopsy. To fill this need of reducing analysis time, CSEM replaced this single AFM cantilever by a cantilever array of several AFM cantilevers operating in parallel. It involves an innovative parallel read-out of the probes consisting in reading the cantilever array with a VCSEL array (Vertical Cavity Surface Emitting Laser). Each laser beam is focused at the end of one cantilever of the array and the reflected light is detected using a photodetector.

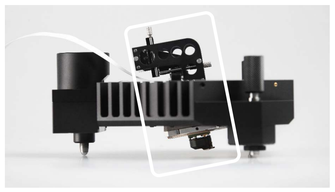




The proof of concept of parallel AFM read-out using 4 channels was demonstrated on agarose gels showing soft tissue-like mechanical properties. The graph shows a calibration on glass.

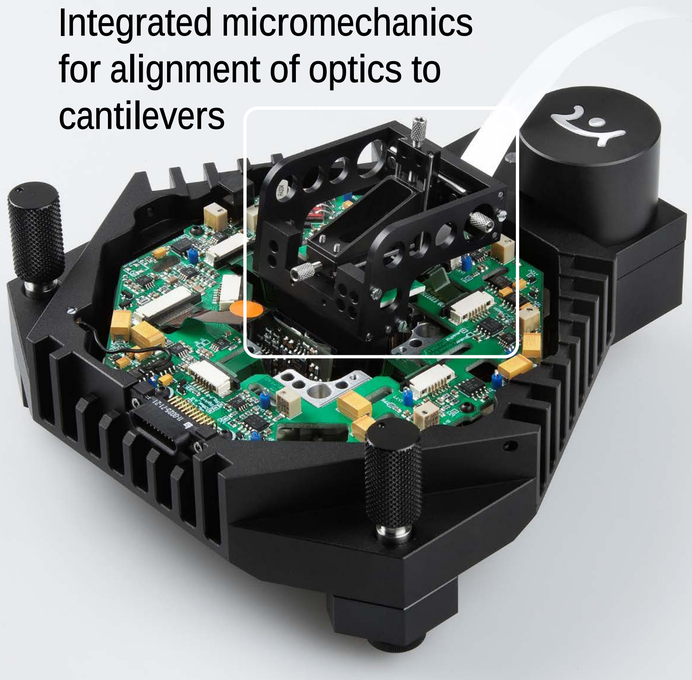
PROTOTYPE

The successful demonstrator is being improved towards a prototype in combination with the commercial AFM-based diagnostic tool called ARTIDIS® (Automated and Reliable Tissue DIagnosticS) from Nanosurf.



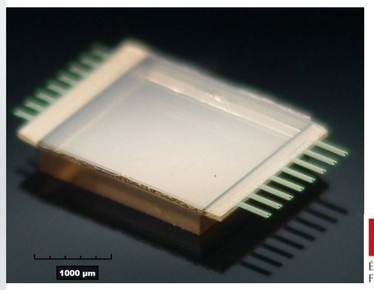
Tilted optics

Integrated micromechanics for alignment of optics to cantilevers



Parallel AFM instrument installed on an inverted microscope

8 probes operating in parallel



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